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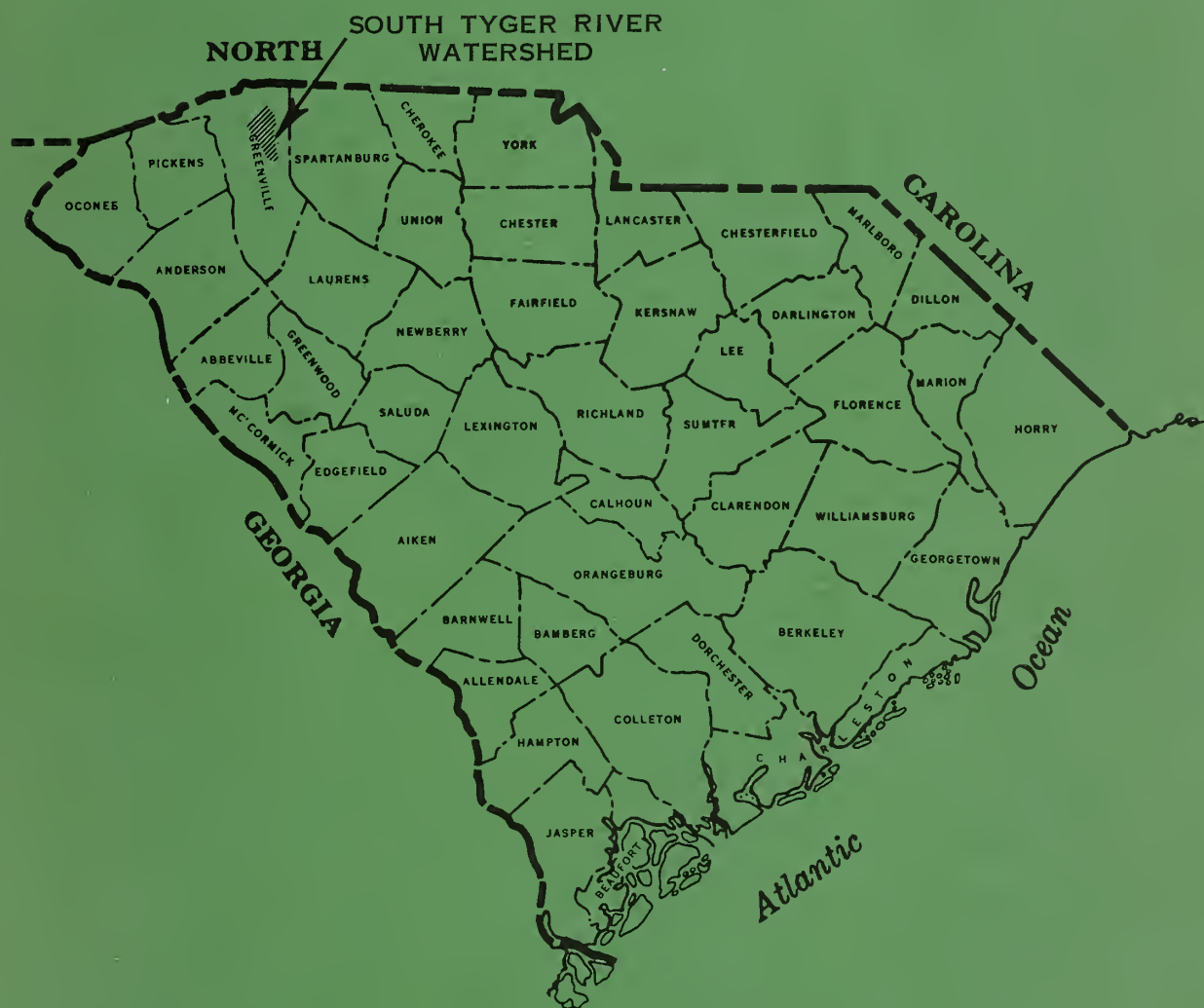
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# REVISED WATERSHED WORK PLAN

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## SOUTH TYGER RIVER WATERSHED Greenville County, South Carolina



U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE  
AND  
FOREST SERVICE

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ADDENDUM

REVISED WATERSHED WORK PLAN  
SOUTH TYGER RIVER WATERSHED  
GREENVILLE COUNTY, SOUTH CAROLINA

CATALOGING - PREP.

DECEMBER 1975

Introduction

This addendum is based on the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources", which became effective October 30, 1973. It is prepared to be consistent with the requirements of the Water Resources Council's Procedure No. 1 for the phase-in of the Principles and Standards. The information presented is:

Part I - Benefits to Cost Comparison

An evaluation of the selected plan without reformulation, using current normalized prices, as built construction costs and 3 1/8 percent interest rate for Structures 2, 4, 5 and the channel work, current construction costs and 3 1/8 percent interest rate for Structures 3D and 6A, and 3 1/4 percent interest rate for Lake Robinson.

Part II - Four Account Displays

Evaluated effects of the selected plan are displayed under separate accounts for (1) National Economic Development, (2) Environmental Quality, (3) Regional Development, and (4) Social Well-Being. The displays are consistent with the intent of the Principles and Standards.

Part III - Abbreviated Environmental Quality Plan

An environmental quality plan, consistent with the intent of the Principles and Standards, but which is abridged in detail, has been developed by an interdisciplinary team. It is an alternative plan to the selected plan and is formulated to enhance environmental quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. This plan was formulated from information and data obtained during the investigative and analysis phases of project planning. Formulation began with the inventory and recognition of the watershed problems and needs. Desired environmental effects, as translated from the problems and needs, provided a basis for examining appropriate water and land resource use and management opportunities. Opportunities that emphasized contributions to the component needs were selected and are

shown as plan elements of the abbreviated environmental quality plan. The cost of \$6,600,000 for its installation is a preliminary estimate.

Implementation of features of this environmental quality plan would require acceptance by the local people. Adequate legal authorities do exist for installation; however, funding for all plan elements is presently not available through existing legislative authorities.

PART IBENEFIT TO COST COMPARISONS

Project cost based on as built or 1974 prices, crop and pasture benefits based on current normalized prices, other benefits based on current prices, and benefit-cost ratio, based on 3 1/4 percent interest rate for Lake Robinson and 3 1/8 percent interest rate for all other structural measures, are as follows:

1. Annual Costs	\$231,300
2. Annual Benefits	\$355,000
3. Benefit-Cost Ratio	1.5 to 1
4. Benefit-Cost Ratio, excluding local secondary benefits	1.4 to 1



PART II - SELECTED PLAN  
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

<u>Components</u>	<u>Measures of effects</u> <sup>1/</sup>
Beneficial effects:	
Value to users of increased output of goods and services	
a. Flood prevention	\$ 57,500
b. Recreation	106,000
c. Municipal & industrial water supply	145,500
d. Utilization of unemployed and underemployed labor resources project construction and operation and maintenance	27,500
Total beneficial effects	\$336,500
Adverse effects:	
Value of resources required for a plan	
Five floodwater retarding structures, one multiple purpose reservoir, and recreation facilities	
project installation (structural measures)	202,100
project administration	10,400
operation and maintenance	18,800
Total adverse effects	231,300
Net Beneficial Effects	\$105,200

<sup>1/</sup> Average annual



PART II - SELECTED PLAN  
ENVIRONMENTAL QUALITY ACCOUNT

Components

Measures of effects

Beneficial and adverse effects:

A. Areas of natural beauty

1. Creates three lakes with 22 miles of shoreline and 853 surface acres of water.
2. Project output makes available regional funds and resources that can be used to enhance the physical appearance of 150 farms.
3. Disrupts tranquility of rural environment by 53,000 recreational visitor-days.
4. Converts approximately 15 acres of the recreational development consisting of pine and mixed hardwoods with heavy, brushy undergrowth into a scenic landscape of native and planted trees, shrubs, and vegetation.
5. Inundates 853 acres presently consisting of bottom land hardwood, pine and mixed hardwoods (663 acres), and openland (190 acres).
6. Clears 26 acres of forest land and 10 acres of pastureland for dams, spillways, and borrow areas.

Components

Measures of effects

B. Quality considerations  
of water, land, and air  
resources

1. Reduces floodwater damages on 951 acres by approximately 88 percent.
2. Reduces sediment deposition into Lake Cunningham from the watershed by 88 percent.
3. Reduces erosion by 30 percent on cropland and 52 percent along roadsides. Erosion on pastureland and forest land will be reduced slightly.
4. Lowers average annual suspended sediment concentration from 194 milligrams per liter to an average of 31 milligrams per liter at the outlet into Lake Cunningham.
5. Degrades ambient air quality and water quality slightly during project construction.
6. Stream water temperature below structures may increase a maximum of five degrees Fahrenheit.

C. Biological resources  
and selected ecosystems

1. Creates 853 acres of lake fishing.
2. Provides resting and roosting areas for waterfowl.
3. Inundates 6.3 miles of stream.
4. Reduces bottom land wildlife habitat by 27 percent.
5. Stops upstream migration of fish by the creation of three lakes.

D. Irreversible or  
irretrievable commitments

Converts 36 acres of forest land and pastureland to dam sites, and emergency and chute spillways; and 853 acres of forest land and pastureland to sediment and permanent water pools in the three lakes; inundates 6.3 miles of streams.

PART II - SELECTED PLAN

REGIONAL DEVELOPMENT ACCOUNT

<u>Components</u>	<u>Measures of effects 1/</u>	
	<u>State of</u> <u>South Carolina</u>	<u>Rest of</u> <u>Nation</u>
A. Income		
Beneficial effects:		
Value of increased output of goods and services to users residing in the region		
1. Flood prevention	\$ 57,500	-
2. Recreation	106,000	-
3. Municipal and industrial water supply	145,500	-
4. Utilization of regional unemployed or underemployed labor resources		
project construction and operation and maintenance	27,500	-
5. Secondary	18,500	-
Total beneficial effects	\$355,000	-
Adverse effects:		
Value of resources contributed from within the region to achieve the outputs		
Five floodwater retarding structures, one multiple purpose reservoir, and recreation facilities		
project installation (structural measures)	\$137,600	\$ 64,500
project administration	2,200	8,200
operation and maintenance	18,800	-
Total adverse effects	\$158,600	72,700
Net Beneficial Effects	\$196,400	-\$72,700

1/ Average annual

<u>Components</u>	<u>Measures of effects</u>	
	<u>State of</u> <u>South Carolina</u>	<u>Rest of</u> <u>Nation</u>
B. Employment		
Beneficial effects:		
Increases in the number and types of jobs		
1. Employment in agriculture, service, and trade activities	6 permanent skilled jobs; 43 permanent semi- skilled jobs	-
2. Employment for project construction	21 skilled jobs for one year; 148 semi-skilled jobs for one year	-
3. Employment for operation, maintenance, and replacement	3 permanent semi-skilled jobs	-
Total beneficial effects	6 permanent skilled jobs; 46 permanent semi- skilled jobs; 21 skilled jobs for one year; 148 semi- skilled jobs for one year	-

<u>Components</u>	<u>Measures of effects</u>	
	<u>State of</u> <u>South Carolina</u>	<u>Rest of</u> <u>Nation</u>
Adverse effects:		
Decreases in number and types of jobs		
1. Loss in agricultural employment of project take area	-	-
2. Loss in forestry industry employment of project take area	1 permanent semi-skilled forestry job	-
Total adverse effects	1 permanent semi-skilled job	-
Net Beneficial Effects	6 permanent skilled jobs; 45 permanent semi- skilled jobs; 21 jobs for one year; 148 semi-skilled jobs for one year	-

<u>Components</u>	<u>Measures of effects</u>	
	<u>State of</u> <u>South Carolina</u>	<u>Rest of</u> <u>Nation</u>
C. Population Distribution		
Beneficial effects:	Water supply and lake creates in-migration and seasonal residents	-
Adverse effects:	-	-
D. Regional Economic Base and Stability		
Beneficial effects:	Creates 6 permanent skilled jobs; 45 permanent semi-skilled jobs; 21 short-term skilled jobs; and 148 short-term semi-skilled jobs	-
	Provides 32 million gallons of water per day to serve 200,000 population in the year 2028	-
Adverse effects:	-	-

PART II - SELECTED PLAN

SOCIAL WELL-BEING

Components

Measures of effects

Beneficial and Adverse effects:

A. Real income distribution

1. Creates 51 low to medium income permanent jobs for area residents.
2. Creates regional income benefit distribution of \$355,200 by income class as follows:

<u>Income Class</u> <u>(dollars)</u>	<u>Percentage of</u> <u>Adjusted Gross</u> <u>Income in Class</u>	<u>Percentage</u> <u>Benefits</u> <u>in Class</u>
Less than \$4,000	16	20
\$4,000 - \$10,000	43	43
More than \$10,000	41	37

3. Local costs to be borne by region total \$159,300 with distribution by income class as follows:

<u>Income Class</u> <u>(dollars)</u>	<u>Percentage of</u> <u>Adjusted Gross</u> <u>Income in Class</u>	<u>Percentage</u> <u>Contribution</u> <u>in Class</u>
Less than \$4,000	16	10
\$4,000 - \$10,000	43	40
More than \$10,000	41	50

According to U.S. Bureau of the Census data for 1970, 12 percent of all families, and 32 percent of all black families in the area had incomes below poverty level.

As the tables above show, installation of the planned project will redistribute income from the higher to the lower income class.



- |                               |  |
|-------------------------------|--|
| B. Life, Health, and Safety   | Provides flood protection to roads and bridges.                            |
| C. Recreational opportunities | Creates 53,000 recreational visitor-day activities for a rural population. |

### PART III

#### ABBREVIATED ENVIRONMENTAL QUALITY PLAN

The goals of this environmental quality plan for the South Tyger River Watershed are to: (1) preserve and enhance areas of natural beauty; (2) maintain and improve the quality of water, land, and air resources; and (3) preserve and enhance the biological resources and ecosystems of the watershed.

The principal environmental problems in the watershed are soil erosion and resulting sediment deposition in Lake Cunningham, lack of adequate water supply, and lack of water based recreational opportunities.

The watershed lies in a rural setting of gently rolling Piedmont terrain interspersed with cropland, pastureland, and forest land. Soil erosion was very severe during the first half of the century when cotton was the principal cash crop. Critically eroding areas and gullies give evidence of past abuse. The dominant forest species are hardwoods and are usually found mixed with shortleaf pines in the natural stands. Pastures are usually planted to fescue, but improved bermuda grass and native grasses are also found. Many acres of pastureland suffer from over-grazing and lack proper management.

Clearing of hardwood stands for solid replanting of pine creates habitat for quail during the first few years of growth; however, solid pine stands five years old or older provide poor habitat for openland wildlife species. Clearing of bottom land hardwoods reduces this type of habitat for deer and other wildlife. Erosion of roadbanks, gullies, and galled areas contributes heavy sediment loads to South Tyger River, its tributaries, and Lake Cunningham. Sediment deposition destroys trees and other vegetation, clogs stream channels, and reduces fish reproduction. No public water-based recreational areas are in the watershed. The community does not have an adequate source of water supply.

Component needs for solving problems relating to specific environmental conditions are listed below:

1. Areas of natural beauty
  - a. reduce sheet, gully, and roadside erosion in the uplands
  - b. reduce sediment into Lake Cunningham

## 2. Quality of water, land, and air resources

- a. improve the quality of the stream flow of South Tyger River by reducing the sediment being delivered to the streams and Lake Cunningham from soil erosion
- b. protect the land from deterioration by reducing erosion and sediment
- c. maintain and enhance soil productivity
- d. provide residents of the community with a dependable water supply

## 3. Biological resources and ecosystems

Preserve and enhance the habitat conditions for species of fish and wildlife present in the watershed by providing more dependable food supplies, avoiding excessive destruction of habitat, reducing losses of habitat from sedimentation, creating additional cover for selected species of wildlife and creating additional habitat for fish.

The plan elements for environmental quality consist of land treatment and structural measures. Cropland treatment measures would consist of conservation treatment systems as follows: (1) terraces, grassed waterways, field borders, land leveling, stripcropping, contour farming, and conservation cropping systems; and (2) grassed waterways, field borders, land leveling, contour farming, conservation cropping systems, and no-till planting. Critically eroding cropland would receive special treatment for the establishment of permanent grasses. Wildlife food plantings would be included in the field border plantings.

The major treatment system on pastureland would include land leveling, removal of undesirable plant species, planting improved grasses and legumes, cross-fencing, ponds, and a complete fertilization and liming program.

Conservation practices on forest land include tree planting, thinning, harvest cutting, wildlife food plantings, timber stand improvement, and protection from grazing and wild fires. In addition, critically eroding areas in forest would receive special treatment to establish permanent vegetation and improve wildlife habitat.

Treatment of land in other uses would include erosion control practices, such as mulching and planting grasses, planting trees, and planting wildlife food plants. Special treatment would be applied to roadbanks and dirt roads. Practices for the improvement of fish habitat and recreational areas would be applied.

Planned land treatment systems would include changed land use on those areas being used beyond their capabilities. These areas would be primarily cropland areas where erosion is a problem. Treatment would be the establishment of grasses, trees, or wildlife cover.

Landowners would be encouraged to apply and maintain land treatment measures by the local soil and water conservation districts, with technical assistance from the Soil Conservation Service, U.S. Forest Service, and other agencies. Financial assistance, usually on a cost-share basis, is available through the Rural Environmental Conservation Program administered by the Agricultural Stabilization and Conservation Service.

One multiple purpose structure would be installed to store sediment, municipal and industrial, and recreational water. Associated with the structure would be a development providing water based recreational facilities and access to the lake. The structural measure would be implemented by the local soil and water conservation district, the watershed conservation district, and the city of Greer. Cost sharing funds for eligible components are available under Public Law 566, as amended.

The estimated installation costs of the elements of the environmental quality plan are as follows:

- |   |              |
|---|--------------|
| 1. Application of land treatment measures | - \$ 600,000 |
| 2. One multiple purpose structure         | - 5,600,000  |
| 3. Recreational facilities                | - 400,000    |

The total installation cost of the environmental quality plan is estimated to be \$6,600,000.

The environmental effects that would result from installation of the environmental quality plan are as follows:

1. Areas of natural beauty
  - a. enhance the appearance of the farms in the watershed through application and maintenance of land treatment measures
  - b. improve the scenic quality of roadsides and galled areas by shaping and revegetation
  - c. improve aesthetic quality of the landscape by providing an 800 acre lake in a wooded and grassed setting
2. Quality of water, land, and air resources
  - a. reduce the sediment load carried by South Tyger River through the reduction of erosion and the storage of sediment in the structure
  - b. reduce the deterioration of the land resource base by special treatment of critically eroding areas
  - c. provide citizens of the area an adequate water supply through the year 2028
  - d. reduce sediment deposited in Lake Cunningham
  - e. slightly degrade air and water quality during project construction



3. Biological resources
  - a. enhance the fishery habitat in Lake Cunningham by reducing sediment deposited
  - b. change 850 acres of forest and pasture habitat to lake fishery
  - c. improve wildlife habitat on the upland through installation of land treatment measures
4. Other  
Provide water based recreational opportunities for an estimated 60,000 visitor days per year
5. Irreversible or irretrievable commitments  
Require a loss of 699 acres of forest and 200 acres of pasture for the pool, dam, spillway, and borrow areas; inundate 6.3 miles of stream.

REVISED WATERSHED WORK PLAN AGREEMENT

between the

South Tyger River Watershed Conservation District  
Greenville County Soil and Water Conservation District  
Commission of Public Works, City of Greer

State of South Carolina  
(hereinafter referred to as the Sponsoring Local Organizations)

and the

Soil Conservation Service  
United States Department of Agriculture  
(hereinafter referred to as the Service)

Whereas, the Watershed Work Plan Agreement for the South Tyger River Watershed, State of South Carolina, executed by the Sponsoring Local Organizations named therein and the Service, became effective on the 23rd day of February 1967; and

Whereas, the said Watershed Work Plan Agreement was modified by Supplemental Watershed Work Plan Agreement Number 1, executed on the 13th day of June 1972; and

Whereas, in order to carry out the watershed work plan for said watershed, it has become necessary to revise and supersede said Watershed Work Plan Agreement, as supplemented; and

Whereas, a Revised Watershed Work Plan which modifies the watershed work plan dated May 1966, for said watershed has been developed through the cooperative efforts of the Sponsoring Local Organizations and the Service, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organizations and the Secretary of Agriculture, through the Service, hereby agree on the revised watershed work plan and further agree that the works of improvement as set forth in said plan can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the revised watershed work plan:

1. The Sponsoring Local Organizations will acquire such land rights as will be needed in connection with the works of improvement. The percentages of this cost to be borne by the Sponsoring Local Organizations and the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations (percent)</u>	<u>Service (percent)</u>	<u>Estimated Land Rights Costs (dollars)</u>
Multiple purpose structure Lake Robinson and recreational facilities			
Payment to landowners for about 1,146 acres acquired by fee title	74.0	26.0	1,146,000
Cost of alteration or modification of improvements <u>1/</u>	74.5	25.5	326,000
Legal fees, survey costs, flowage ease- ments, and other	100	0	284,800
All other structural measures	100	0	227,100

1/ Including necessary engineering services, construction, and additional land costs

The Sponsoring Local Organizations agree that all land acquired or improved with PL-566 financial or credit assistance will not be sold or otherwise disposed of for the evaluated life of the project, except to a public agency which will continue to maintain and operate the development in accordance with the Operation and Maintenance Agreement.



2. The Sponsoring Local Organizations assure that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894), effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Sponsoring Local Organizations and the Service as follows:

	<u>Sponsoring Local Organizations</u> (percent)	<u>Service</u> (percent)	<u>Estimated Relocation Payment Costs</u> (dollars)
Relocation Payments	39.4	60.6	30,000

3. The Sponsoring Local Organizations will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement.
4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organizations and by the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations</u> (percent)	<u>Service</u> (percent)	<u>Estimated Construction Cost</u> (dollars)
Five floodwater retarding structures	0	100	558,400
Two miles of channel work	0	100	8,600
Multiple Purpose Structure Lake Robinson			
Structure	75.5	24.5	2,953,700
Water Release Gates	100	0	18,300
Grubbing M&I Pool	100	0	28,000
Recreational Facilities	50.0	50.0	140,000

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organizations and the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations (percent)</u>	<u>Service (percent)</u>	<u>Estimated Engineering Cost (dollars)</u>
Five floodwater retarding structures	0	100	72,600
Two miles of channel work	0	100	1,100
Multiple Purpose Structure Lake Robinson			
Structure	60.6	39.4	188,800
Water Release Gates	100	0	1,100
Grubbing M&I Pool	100	0	1,700
Recreational Facilities	50.0	50.0	8,400

6. The Sponsoring Local Organizations and the Service will each bear the costs of Project Administration which it incurs, estimated to be \$65,300 and \$242,700, respectively.
7. The Sponsoring Local Organizations will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organizations will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan. For the treatment of critical areas, the following division of work will be followed:

	<u>Sponsoring Local Organizations</u>	<u>Service</u>
Tree planting	Provide trees Provide mulch Construct fence(s)	Prepare site Plant trees Furnish and plant grasses and legumes
Critical areas in fields	Prepare site and construct fence(s)	Provide and apply seed, plants, lime, and fertilizer
Critical areas along roadsides	Prepare site Construct fence(s)	Provide and apply seed, plants, lime, fertilizer, and mulch

9. The Sponsoring Local Organizations will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.
10. The Sponsoring Local Organizations will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.
11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the availability of appropriations for this purpose. A separate agreement will be entered into between the Service and the Sponsoring Local Organization(s) before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.
13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated only by mutual agreement of the parties hereto except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties. An amendment to incorporate changes affecting one specific structural measure may be made by mutual agreement between the Service and the Sponsor(s) having specific responsibilities for the particular structural measure involved.
14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.
15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving federal financial assistance.
16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.



SOUTH TYGER RIVER WATERSHED  
CONSERVATION DISTRICT

Local Organization

By

M D Burtin

Title

Chairman

Date

12-18-75

P.O. Box 10328, Fed. Sta.  
Address Zip Code  
Greenville, S.C. 29603

The signing of this agreement was authorized by a resolution of the governing body of the South Tyger River Watershed Conservation District  
Local Organization

adopted at a meeting held on 12-18-75

Paul J. Wood  
Secretary, Local Organization

P.O. Box 10328, Fed. Sta., Greenville, S.C.  
Address Zip Code 29603

Date 12-18-75

GREENVILLE COUNTY SOIL AND  
WATER CONSERVATION DISTRICT

Local Organization

By

A B Burnett Jr

Title

Chairman

Date

12-19-75

P.O. Box 10328, Fed. Sta.  
Address Zip Code  
Greenville, S.C. 29603

The signing of this agreement was authorized by a resolution of the governing body of the Greenville County Soil and Water Conservation District  
Local Organization

adopted at a meeting held on 12-19-75

George W. Howard  
Secretary, Local Organization

Rt. 3, Greer, S.C. 29651

Address

Zip Code

Date 12-19-75

COMMISSION OF PUBLIC WORKS,  
CITY OF GREER

Local Organization  
P. O. Box 216

Greer, S. C. 29651

Address

Zip Code

By

W. E. James Jr.

Title

Chairman

Date

12/17/75

The signing of this agreement was authorized by a resolution of the governing body of the Commission of Public Works, city of Greer

Local Organization

adopted at a meeting held on December 17, 1975

Thana Schell  
Secretary, Local Organization

202 W. Poinsett St., Greer, S.C. 29651

Address

Zip Code

Date

12-17-75

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service  
United States Department of Agriculture

Approved by:

L. W. Dameron

Acting State Conservationist

December 23, 1975

Date

THE REVISED WATERSHED WORK PLAN

SOUTH TYGER RIVER WATERSHED

Greenville County  
South Carolina

Prepared under the Authority of the  
Watershed Protection and Flood Prevention  
Act (Public Law 566, 83d Congress,  
68 Stat. 666), as amended.

Prepared by: South Tyger River Watershed Conservation District  
Greenville County Soil and Water Conservation District  
Commission of Public Works, City of Greer

With Assistance by:

U.S. Department of Agriculture, Soil Conservation Service  
U.S. Department of Agriculture, Forest Service

December 1975





# T A B L E   O F   C O N T E N T S

	<u>Page</u>
PREFACE	1
SUMMARY OF PLAN	1
ENVIRONMENTAL SETTING	3
Physical Data	3
Economic Data	7
Fish and Wildlife Resources	10
Recreational Resources	11
Archeological and Historical Values and Unique Scenic Areas	12
Soil, Water and Plant Management Status	12
WATER AND RELATED LAND RESOURCE PROBLEMS	13
Land Treatment	13
Floodwater Damage	14
Erosion Damages	14
Sediment Damage	15
Municipal and Industrial Water	16
Recreation	16
Economic and Social	16
PROJECTS OF OTHER AGENCIES	17
PROJECT FORMULATION	17
Objectives	17
Environmental Considerations	18
Alternatives	18
WORKS OF IMPROVEMENT TO BE INSTALLED	19
Land Treatment Measures	19
Structural Measures	21
EXPLANATION OF INSTALLATION COSTS	30
EFFECTS OF WORKS OF IMPROVEMENT	32
Flood Prevention, Erosion and Sediment	32
Water Supply	33
Fish and Wildlife and Recreation	33
Archeological, Historic, and Scientific	34
Economic and Social	34
Other	36

PROJECT BENEFITS	37
COMPARISON OF BENEFITS AND COSTS	38
PROJECT INSTALLATION	38
FINANCING PROJECT INSTALLATION	40
PROVISIONS FOR OPERATION AND MAINTENANCE	41

#### TABLES

TABLE 1 - Estimated Project Installation Cost
TABLE 2 - Estimated Structural Cost Distribution
TABLE 2A - Cost Allocation and Cost Sharing Summary
TABLE 2B - Recreational Facilities, Estimated Construction Costs
TABLE 3 - Structural Data, Structures With Planned Storage Capacity
TABLE 3A - Structural Data, Channels
TABLE 4 - Annual Cost
TABLE 5 - Estimated Average Annual Flood Damage Reduction Benefits
TABLE 6 - Comparison of Benefits and Costs for Structural Measures

INVESTIGATIONS AND ANALYSES	53
Land Use and Treatment	53
Structures	53
Geology	56
Hydrology	57
Economics	58

#### APPENDICES

APPENDIX A - South Carolina Drinking Water Standards
APPENDIX B - Quality Standards for Class "B" Waters
APPENDIX C - Surface Water Quality in South Tyger River Watershed

#### MAPS

Project Map
Public Recreation Development Area
South Tyger River Recreational Area

THE REVISED WATERSHED WORK PLAN  
SOUTH TYGER RIVER WATERSHED  
Greenville County, South Carolina

PREFACE

A Work Plan was developed for the South Tyger River Watershed in May 1966, and approved for installation in February 1967. Three floodwater retarding structures and about two miles of channel work have been completed. The remaining structural measures include two floodwater retarding structures, one multiple purpose structure (No. 1) and 13 miles of channel work. This revision deletes the remaining 13 miles of channel work and multiple purpose Structure 1 and adds a multiple purpose structure (Lake Robinson). In addition, the Commission of Public Works, City of Greer, is added as a sponsor.

SUMMARY OF PLAN

The watershed comprises an area of 38,147 acres in northern Greenville County. This county is included in the Appalachian Regional Development Act of 1965 (Public Law 89-4). The greater part of the watershed has been in cultivation in former years. All of the agricultural land is privately owned.

The flood plain area includes 3,120 acres which are subject to frequent flooding. Overbank flow occurs on the average of 2.5 times per year. A flood inundating one-half of the flood plain occurs on the average of 1.5 times per year. Because of this flood hazard, only 1,150 acres or about 37 percent of the flood plain is in agricultural use, and the remainder is idle or has reverted to brush and low-value hardwoods. Flooding has caused sediment damage on 1,340 acres. Damage ranges from 20 to 90 percent as measured by reduced productivity. A total of 230 acres has been damaged by scouring. Damage ranges from 20 to 50 percent of productivity.

Land treatment measures such as terraces, field drainage ditches, waterways, stock-watering ponds, tree planting, forest stand improvement, pasture planting, and wildlife habitat development will be installed by landowners under conservation farm plans with the Greenville County Soil and Water Conservation District. Technical assistance in the planning and application of these measures will be provided by the Soil Conservation Service. The South Carolina State Commission of Forestry, with the cooperation of the U.S. Forest Service, will furnish technical assistance for tree planting and hydrologic stand improvement measures. The roadside erosion control and critical area planting will be installed by landowners,

or by contract(s) administered by the South Tyger River Watershed Conservation District.

The cost of land treatment measures is estimated to be \$424,700, of which \$95,500 will be provided from PL-566 funds and \$329,200 from other funds. Approximately 80 percent of land treatment measures in the original work plan have been installed.

The total cost of structural measures is \$6,302,600 of which \$2,154,700 will be provided from PL-566 funds and \$4,147,900 from other funds.

About 85 family farms will receive direct benefits from the works of improvement. Flood plain holdings range in size from one to 140 acres. Residents of the entire area will benefit from the municipal and recreational water storage in Lake Robinson. All residents of the watershed and surrounding area will receive indirect benefits from the increased income stemming from the project. The utilization of the flood plain for the production of improved pasture and row crops will result in increased income to farmers.

The multiple purpose structure (Lake Robinson) will provide a yield of 32 million gallons per day for municipal use and 734 acre feet of storage for recreation. In addition, it will reduce the sediment entering Lake Cunningham which is located just downstream.

The total project cost is estimated to be \$6,727,300, of which \$2,250,200 will be PL-566 funds and \$4,477,100 other funds. Some of these costs have already been incurred. The completed measures have cost \$765,800. Of this, \$426,700 were provided by PL-566 funds.

The South Tyger River Watershed Conservation District will assume the responsibility for the operation and maintenance of all structural measures, except Lake Robinson. The Commission of Public Works, City of Greer, will be responsible for operation and maintenance of Lake Robinson. The annual operation and maintenance cost for this structural measure is estimated to be \$1,100. The Commission of Public Works, City of Greer, will be responsible for the operation and maintenance of the recreation development associated with Lake Robinson. This cost is estimated to be \$14,700. Land treatment measures will be maintained by the individual landowners concerned, in accordance with the provisions of their conservation plan with the Greenville County Soil and Water Conservation District.

The average annual benefits from the structural measures are \$355,000. The average annual cost amounts to \$231,300, indicating a benefit to cost ratio of 1.5 to 1.



## WATERSHED RESOURCES - ENVIRONMENTAL SETTING

### Physical Data

The South Tyger River Watershed consists of 38,147 acres in the lower Blue Ridge-upper Piedmont region of South Carolina. The entire watershed lies within Greenville County. South Tyger River Watershed is bordered on the east by Middle Tyger River, on the northwest by North Saluda River and on the southwest by Enoree River. The watershed's 12 mile length extends from four miles north of the Tigerville community to Lake Cunningham. Tigerville community, the home of North Greenville Junior College, is located in the north central portion of the area. Greenville, a city of 61,436<sup>1/</sup>, is 11 miles southwest and Greer, a city of 10,642<sup>2/</sup>, lies five miles south of the watershed boundary. The population of the watershed is about 10,000. Approximately one-half is classed as rural. The other residents hold off-farm jobs but engage in part-time farming.

South Tyger River is a tributary of Tyger River within the Santee River Basin. It is in the South Atlantic-Gulf Region and the Santee-Edisto subregion as designated by the U.S. Water Resources Council<sup>3/</sup>. The northern one-third of the watershed lies in the East and Central General Farming and Forest Region. Small, general farms are characteristic of much of this region, but there are large dairy and livestock farms on some areas of the more favorable soils. Relief in this part of the watershed ranges from gently rolling to steep hills. The southern two-thirds of the area lies in the South Atlantic and Gulf Slope Cash Crop, Forest, and Livestock Region. This is the traditional cotton region and consists of gently sloping to rolling southern Piedmont. Rainfall averages 49 inches annually and is seasonally well distributed. The mean annual temperature is 61 degrees Fahrenheit, with monthly means varying from 45 degrees in January to 79 degrees in July. The average length of the growing season is 219 days<sup>4/</sup>. Land form elevations above mean sea level range from 83 to 2,300 feet.

Soils with sandy loam surface layers are dominant throughout the

<sup>1/</sup> County and City Data Book 1972, U.S. Department of Commerce, Bureau of the Census

<sup>2/</sup> Ibid

<sup>3/</sup> Water Resources Regions and Subregions for the National Assessment of Water and Related Land Resources, July 1970, Water Resources Council, Washington, D.C.

<sup>4/</sup> Atlas of River Basins of the United States, prepared by U.S. Department of Agriculture, Soil Conservation Service, June 1963.

watershed. Soils with clayey subsoils are most common in the southern two-thirds of the watershed. Soils with loamy subsoils occur in the mountains, foothills, and flood plains. Most soils in the Piedmont are gently sloping or sloping and most soils in the Blue Ridge are moderately steep to very steep. Erosion is a severe problem on approximately 400 acres. The flood plain soils are subject to flooding and most have free water at one to two feet below the surface about 60 days per year. With proper water management, these soils are well suited to intensive agricultural use. The principal soil series and their important characteristics are<sup>1/</sup>:

<u>Soil Series</u>	<u>Slope Range</u> (percent)	<u>Permeability</u>	<u>Depth</u>	<u>Watershed</u> <u>Area</u> (percent)
Piedmont soils- clayey subsoils				
Cecil	2-15	Moderate	Deep	27
Pacolet	10-40	Moderate	Mod. Deep	10
Hiwassee	2-25	Moderate	Deep	7
Appling	2-10	Moderate	Deep	3
Blue Ridge soils- loamy subsoils				
Brevard	6-25	Moderate	Deep	8
Evard	15-70	Moderate	Mod. Deep	6
Edneyville	6-70	Moderate	Mod. Deep	11
Ashe	25-90	Mod. Rapid	Shallow	3
Saluda	15-80	Moderate	Shallow	4
Flood plain soils- loamy subsoils				
Cartecay	Nearly level	Mod. Rapid	Deep	5
Toccoa	Nearly level	Mod. Rapid	Deep	3
Soils with an areal extent of less than three percent of the watershed area				13

<sup>1/</sup> Soil Survey Greenville County, South Carolina, U.S. Department of Agriculture, Soil Conservation Service, 1975.



Classification of watershed soils by capability class and sub-class is shown below<sup>1/</sup>:

<u>Capability Class and Subclass</u>	<u>Percentage of Watershed Area</u>	<u>Number of Acres</u>
IIe	15	5,700
IIIe	20	7,600
IVe	15	5,700
VIe	22	8,427
VIIe	20	7,600
IIIw	8	3,120

The land capability classification system is the grouping of soils to show, in a general way, their suitability for use of cropland, pastureland, and wildlife. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The letter "e" indicates that erosion is the primary hazard and "w" designates a wetness hazard. Capability Classes II and III include those soils suitable for annual or periodic cultivation of row crops. Capability Class IV includes those soils on which cultivation should be undertaken only occasionally or under very careful management. Capability Classes VI and VII include those soils considered unsuitable for cultivation of row crops, but are suitable for pasture, forest or wildlife use. With very careful management, some areas of Classes VI and VII are suitable for use as apple orchards.

Geologic features in this area consist of the Inner Piedmont Belt as described by Overstreet and Bell. The core of the Inner Piedmont Belt, which underlies the watershed, consists of migmatites, schists, and gneisses. Many granite bodies are present; pegmatite is abundant. The schists range from gray to black and are fine to coarse grained. They contain thin layers of gneiss, quartzite, and marble. Garnet and sillimanite are common inclusions. There are many veins of gneissic pegmatite dispersed throughout the above materials. The geologic ages of these materials range from Upper Precambrian to Mississippian<sup>2/</sup>.

There is one mining operation in the watershed at present. A sand-gravel-asphalt operation is located on Beaverdam Creek near State Highway 253. Potential crushed stone locations occur approximately

<sup>1/</sup> Ibid.

<sup>2/</sup> Overstreet, W. C., and Bell, H. III, The Crystalline Rocks of South Carolina, Geological Survey Bulletin 1183, 1965.

three miles north of Tigerville and two to three miles south of Tigerville on Beaverdam Creek<sup>1/</sup>. Gold was mined on Wildcat Creek near the east-central boundary of the watershed but apparently was exhausted during "the fifties" (1850)<sup>2/</sup>. Mica and other clay minerals have been produced near the Tigerville community, but all operations have ceased. Large crystals of zircon have been found in place at the old vermiculite mines or in creek bottoms of the vicinity<sup>3/</sup>. Other mineral values have not been assessed at this time.

The source for ground water is highly weathered and fractured zones in the granite gneiss. These weathered zones or aquifers have developed along faults and fractures in the bedrock. Areas along the base of the hillsides or within the valleys are potentially the best locations for ground water exploration. The average depth of drilled wells is 134 feet and the average yield is 11 gallons per minute. Most of the water obtained from granite gneiss is slightly acidic. In 16 samples, the pH ranged from 6.0 to 7.4. The water is generally soft. A hardness of 60 milligrams per liter (mg/l) is rare. The iron content ranged from 0.0 to 7.0 mg/l. When ground water is used for public consumption, it must meet state standards. Dug wells of the area usually range from 10 to 50 feet, but some are as deep as 100 feet. These wells usually yield a large amount of water for several minutes because they are reservoirs, but once the water is removed the soil and rock yield only about one to five gallons per minute<sup>4/</sup>. Many of the rural residents have joined the Blue Ridge Rural Water Company. Persons having commercial water in their household now use their well water for livestock and irrigation.

South Tyger River heads as Noe Creek in Greenville County, approximately four miles north of Tigerville. It flows southeastward for a distance of 12 miles where it enters Lake Cunningham at the watershed outlet. Its major tributaries are Burban Fork Creek, McKinney Creek, Barton Creek, Meadow Creek, Mush Creek, Peck Creek, Wildcat Creek, and Beaverdam Creek. All of these streams are perennial. Field and map surveys indicate there are approximately 70 miles of perennial streams in the watershed. Each perennial stream is supported by 50 to 150 miles of intermittent stream. A field survey of selected streams indicates that a drainage area of 25 to 200 acres, with one

<sup>1/</sup> South Carolina State Development Board, Geology Division, personal contact 1974.

<sup>2/</sup> Catalogue of The Mineral Localities of South Carolina, pg. 32, Earl Sloan, 1908, Reprint South Carolina State Development Board, 1958.

<sup>3/</sup> Gem Stone Resources of South Carolina, C. K. McCauley, Bulletin No. 30, Division of Geology, State Development Board, Columbia, South Carolina, 1964.

<sup>4/</sup> Ground Water Resources of Greenville County, South Carolina, N. C. Koch, Bulletin No. 38, South Carolina State Development Board, 1968.

to five miles of ephemeral drainageways, is needed to originate an intermittent stream.

South Tyger River is classified by the South Carolina Department of Health and Environmental Control as a Class "B" stream<sup>1/</sup>. This classification is assigned to a stream after a public hearing as being the stream quality desired. The actual stream quality may be better or worse than the classification assigned. The current state policy is to improve all stream quality. After a classification is selected, then it becomes law that nothing may be done to lower the water quality below the assigned value. A Class "B" stream has the standard of being suitable for municipal and recreational purposes, excluding swimming. (See Appendix B.) For raw surface water quality at selected points on South Tyger River, see Appendix C.

There are an estimated 50 farm ponds within the watershed. The average size of these ponds is four to five acres. These ponds usually hold water throughout the year, providing water for livestock, recreation and limited irrigation. There are three flood prevention lakes within the watershed. These lakes and their sites numbers as shown on the Project Map are:

<u>Site Number</u>	<u>Permanent Water</u> (acres)	<u>Floodwater</u> (acres)
2	12	64
4	14	67
5	15	63

Lake Cunningham, a 175 acre reservoir and the water supply for the city of Greer, is located at the outlet of the watershed. Dysart Lake, located in the headwaters of Meadow Fork Creek, has a surface area of about 10 acres.

#### Economic Data

There are about 350 farms and several hundred small tracts used primarily as rural homesites in the watershed. The primary employment is nonfarm industrial jobs. The average farm contains 80 acres and is valued at \$70,000, including buildings and improvements. Flood plain holdings range in size from one to 140 acres. Upland values range from \$400 to \$1,800 per acre. Flood plain land values range from \$400 to \$1,000 per acre.

<sup>1/</sup> Stream Classifications for the State of South Carolina, South Carolina Department of Health and Environmental Control, 1972.



The agricultural pattern consists of general farming practices rather than specialized enterprises. The typical farm is producing row crops, pastures, cattle and forest products. The cultivated land is primarily used for the production of small grains, corn, soybeans, and vegetable crops. The average upland yield per acre for corn is 55 bushels and soybeans is 25 bushels. Yields in the flood plain for corn range from 80 bushels in years without flood damage to almost nothing following flooding. Annual grazing yields per acre average about three animal unit months on upland and five animal unit months on flood plain land.

Thirty-four percent of the farms are considered as commercial. A further breakdown of commercial farms shows that within this group there is a high percentage of farms that fall in Economic Class VI, or that have total sales of less than \$2,500. About 78 percent of all farms have sales of less than \$2,500 per year. Economic classes of farms as listed in the Census of Agriculture, 1969, are as follows:

<u>Class of Farm</u>	<u>Value of Farm Products Sold</u>	<u>Number in Watershed</u>
I	\$40,000 and over	11
II	\$20,000 to \$39,999	9
III	\$10,000 to \$19,999	11
IV	\$ 5,000 to \$ 9,999	13
V	\$ 2,500 to \$ 4,999	34
VI	\$ 50 to \$ 2,499	42
Non-commercial	\$ 50 to \$ 2,499	230

The land use in the watershed is as follows:

<u>Land Use</u>	<u>Acres</u>	<u>Percent</u>
Cropland	4,460	12
Pasture & Idle	6,910	18
Forest land	24,800	65
Miscellaneous	1,977	5
Total	38,147	100

Forest land in the watershed encompasses approximately 24,800 acres, or 65 percent of the watershed. Of this, 23,580 acres are in upland types and 1,220 acres are in bottom land types.

Upland forest types are 6,060 acres in loblolly-shortleaf pine;

3,980 acres in oak-pine; and 13,540 in oak-hickory<sup>1/</sup>. Major species consist of loblolly, shortleaf and Virginia pine, various oaks, mainly southern red, scarlet, black and white oaks, hickory, red maple, and sweetgums.

About 2,000 acres of the loblolly-shortleaf pine stands are in plantations; the remaining 4,000 acres in natural stands. Very few of the plantations and none of the natural stands are 100 percent pine. Although classified as pine stands, they can contain up to 25 percent hardwoods.

Bottom land types contain a variety of species including red maple, yellow poplar, red gum, black gum, water oak, cottonwood, sycamore, and river birch. Understory species are willow, willow oak, dogwood, maple, ironwood, and box elder.

Stand size classes are 33 percent sawtimber, 41 percent poletimber, and 26 percent seedling-sapling<sup>2/</sup>.

Acreage of commercial forest land by site classes are<sup>3/</sup>:

<u>Site Class</u>	<u>Present Acreage</u>	<u>Percent</u>
1	0	0
2	1,587	6
3	5,232	21
4	13,912	56
5	4,069	17

Site class is a classification of forest land in terms of inherent capacity to grow crops of wood<sup>4/</sup>. Soils were used as an indicator of potential productivity to estimate site index, volumes of wood per acre, and acreages of each site class.

Site class 1 is capable of producing 165 or more cubic feet per acre annually; site class 2, between 120 and 165; site class 3, between 85 and 120; site class 4, between 50 and 85; and site class 5, less than 50 cubic feet annually<sup>5/</sup>.

<sup>1/</sup> Basic data derived from USDA - Forest Service "Resource Bulletin SE-9 for Piedmont of South Carolina", 1967, and adjusted, based on field observations.

<sup>2/</sup> Ibid.

<sup>3/</sup> Ibid.

<sup>4/</sup> Ibid.

<sup>5/</sup> Ibid.

Acceptable growing stock groups are:

greater than 70 percent (fully stocked)	-	4,068 acres
50 to 70 percent (medium stocked)	-	14,451 acres
less than 50 percent (poorly stocked)	-	6,281 acres

The following table illustrates the present growing volume of growing stock in the watershed, the average annual growth, and the average annual removals<sup>1/</sup>.

	<u>Growing Stock</u>	<u>Annual Growth</u>	<u>Annual Removals</u>
	----- (million cubic feet) -----		
Pine	5.61	0.46	0.25
Other Softwoods	0.05	0.00	0.00
Soft Hardwoods	5.22	0.30	0.14
Hard Hardwoods	11.24	0.41	0.18
Total	<u>22.12</u>	<u>1.17</u>	<u>0.57</u>

With less than half of the annual growth being removed, the volume of growing stock will continue to increase. Markets for sawtimber are available within the county for both pine and hardwood. However, pulpwood must be transported some 75 miles to Canton, North Carolina or 225 miles to Charleston, South Carolina.

Since pulpwood stumpage value is low, the incentive for the small landowner to practice forest management is lacking. Little harvesting, other than land clearing, thinnings, stand establishment or cultural practices, has been accomplished in recent years.

Except for land used for public schools, North Greenville Junior College, highways, municipal buildings and post offices, all of the land is in private ownership.

#### Fish and Wildlife Resources

Generally, the game fish populations are limited to the 50 farm ponds and three floodwater retarding structures. Moderate fishing pressure exists along South Tyger River for about two miles above Lake Cunningham, but because of infertility of stream water and turbidity, fishing pressure in the remainder of the watershed is extremely light.

<sup>1/</sup> Ibid.



The streams in the watershed have been classified by fishery biologists of the South Carolina Wildlife and Marine Resources Department as bullhead-sucker streams. Brown bullheads and redhorse suckers are the dominant species in the streams. Other species include yellowfin, warpaint, and popeye shiners, white madtom, and flat catfish, redbreast, bluegill, redear and pumpkinseed sunfishes, warmouth, black and white crappies, largemouth bass, several species of darters, gizzard shad, carp and bluehead chub.

Two of the three floodwater retarding structures which have been constructed were stocked with bream and bass. Fishing began in the summer of 1971 at one site and in 1972, at the other. Residents report good fishing in both reservoirs. One structure has only recently been completed.

The areas cleared for the two miles of channel work completed have a dense cover of shrubby growth which attracts songbirds such as thrushes, cardinals, towhees, catbirds, hooded warblers and others.

The forested areas of the flood plain are Type 1 wetlands characterized by mature bottom land trees. The dense overstory has reduced herbaceous vegetation underneath. No swamp or marshy areas which would attract waterfowl exist in the watershed.

The principal wildlife species in the watershed are squirrel, rabbit, quail and doves, however, any species common to this area of the Piedmont could occur. No rare or endangered species are known to exist in the watershed.

### Recreational Resources

Hartwell Reservoir, developed by the U.S. Army Corps of Engineers, is about 35 miles west of the watershed and Table Rock State Park is about 25 miles west. Paris Mountain and Pleasant Ridge State Parks are about five miles and 12 miles from the proposed recreation development, respectively. The three state parks have a combined total of 184 family camp sites. Each park has swimming facilities, picnic tables and nature trails. Pleasant Ridge State Park has one vacation cottage and Table Rock State Park has 12 cottages. One recreation area has been developed on Hartwell Reservoir in South Carolina. This development is near the dam, about 50 miles southwest of the watershed. A 1,000 acre state park is under development on the Keowee-Toxaway Lakes, about 35 miles west of the watershed.

All of the recreational developments in the area experience high seasonal usage. Recent census data indicates a population of 400,000 people within a 25 mile radius of the proposed development. Based on the existing and projected needs, the South Carolina Department of Parks, Recreation and Tourism has designated this area as needing

a new state park<sup>1/</sup>. The proposed development will help satisfy the needs.

#### Archeological and Historical Values and Unique Scenic Areas

There are no historic sites in South Tyger River Watershed that are listed in the National Register of Historic Places. Several historic homes, as identified by the South Carolina Department of Archives and History, are located in the upland areas near the watershed boundary. These have the potential to be included in the National Register.

A field reconnaissance was made within the watershed by the Institute of Archeology and Anthropology, University of South Carolina. No significant archeological values were identified. A detailed report has been prepared by the Institute.

#### Soil, Water, and Plant Management Status

Changes in land use in the South Tyger River Watershed during the past 20 years have included a reduction in row crops, an increase in pastures and an increase in the number of homes. Cotton has disappeared. Soybeans, feed grains, and the number of beef cows have increased. Several hundred homes have been built, mostly on small tracts subdivided from farms along the roads. The watershed is about halfway between Greenville and Spartanburg and trends indicate that there will be an increasing number of families moving into the area.

Tenant-operated farm operations have about disappeared. The current trend is for larger operations with equipment and labor to cash-rent several farms for more efficient operations. There are still numerous marginal farm operations. Cattle farming where fields are planted to permanent grasses has decreased erosion rates considerably, but uncertain markets and small size operations provide small profits.

Technical assistance, educational programs, and loans are available to farmers and other landowners through state and federal agencies. The South Carolina State Commission of Forestry, in cooperation with the U.S. Forest Service, is providing forest management assistance, forest fire protection and suppression, distribution of planting stock and forest pest control assistance. Loans are available to eligible landowners through the Farmers Home Administration to help finance soil and water conservation practices. The Cooperative Extension Service of Clemson University, through the

<sup>1/</sup> SCORP-70, South Carolina Department of Parks, Recreation and Tourism, Columbia, South Carolina, 1970.

county agricultural extension agents, is assisting with information and educational programs. The Vocational Agricultural Programs in the public schools educate youth and adult groups in conservation and land management. The Agricultural Stabilization and Conservation Service administers the Rural Environmental Conservation Program which provides cost sharing assistance to qualified landowners for erosion and sediment control practices and forest management.

The Greenville County Soil and Water Conservation District has active programs that encourage planning and application of conservation measures. Other activities of the district include cooperative seed purchase, operation of equipment, and educational programs. The district is a sponsor of the Rabon Creek Watershed project. The Soil Conservation Service assists the soil and water conservation district. About 225 landowners are cooperators with the district and 200 of these have soil and water conservation plans covering more than 70 percent of the watershed. Approximately 80 percent of the planned land treatment practices have been applied and more than half of the land is adequately protected from erosion. Soil surveys have been completed for the watershed.

#### WATER AND RELATED LAND RESOURCE PROBLEMS

##### Land Treatment

Most of the crops and pasture in the watershed are on land Classes IIe, IIIe, and IVe. These soils are subject to erosion if not properly managed. Low farm incomes have resulted in poorly maintained water disposal systems and improper land use on many farms. Landowners have not committed enough resources to conservation of their soil.

Financial cost-sharing, as well as accelerated technical assistance is needed to encourage land use adjustments and apply needed measures.

The hydrologic condition of the forest land is 31 percent very poor, 20 percent poor, 38 percent fair, and 11 percent good. The relatively poor condition throughout the watershed is due to overcutting of the forests, overgrazing in the forest and past cultivation of lands that have recently returned to forests. This poor condition prohibits the soil from receiving large amounts of rainfall through infiltration, thus causing overland flow during heavy rainfall, erosion within the forests, additional sediment in the streams, and additional flooding of the bottom lands.

There were about 200 acres of severely eroding forest lands when the work plan was first prepared in 1966. All of this has now been planted to trees, to other vegetation, or has reverted to trees through natural regeneration.

Although major streams overflow their banks occasionally and deposit sediment along the bottom land forests, very little damage is caused to the existing forest stands from the flooding or from sediment deposits.



However, due to the occasional flooding and the normally wet soil conditions, landowners are reluctant to do any forest management in these fertile bottom lands. Individual trees are harvested, but stands are normally left alone. Over the years, this lack of management has left these stands with mostly noncommercial species, or commercial species of very poor quality.

#### Floodwater Damage

Damage from floodwater is a major problem in the watershed. Existing channels are not adequate to contain the runoff from frequent storms.

An analysis of storm events from 1934 through 1970, indicates that flooding can be expected to occur on an average of about 2.5 times per year. Floods large enough to inundate 50 percent of the flood plain can be expected about 1.5 times per year. The most intense rainfall during this period occurred on October 6, 1949, when 4.97 inches of rain fell in three hours. Other major storms during the period occurred on August 12, 1940 when 6.33 inches fell in 12 hours and on July 4, 1968 when 5.21 inches fell. Records indicate that about 55 percent of floods in this area occur during the months of March through October.

As a result of flooding, much of the fertile flood plain has been abandoned. Crops have been moved to hill lands to avoid flooding, but, as a result, erosion has been increased. Costs of production are higher and yields are lower on the uplands. In some cases, soils are not being used within their capabilities. Owners cannot manage their farmland to the best advantage under these conditions.

There are 3,120 acres of flood plain land within the watershed, of which 1,150 are in pasture, corn, and truck crops. All corn and truck crops are now being grown in the upper reaches where the threat of flooding is not as great. Most of the downstream flood plain is now in pasture and forest and is subject to frequent inundation. The flood plain has previously been used for the production of row crops and pasture; however, present flooding makes it uneconomical to improve and manage these areas for maximum production.

Floodwater damage to roads and bridges is a serious problem at 15 locations. Farm fences are frequently damaged by direct water pressure against posts and by the impact of flooding debris.

The total average annual floodwater damage without the project amounts to \$23,200.

#### Erosion Damage

Erosion rates on cultivated land are considerably above the tolerable four tons per acre annual soil loss. The soils on steeper slopes are susceptible to development of critically eroding areas. Soil losses on pastureland, forest land, industrial sites,

and urban developments are generally within acceptable limits. Average annual erosion rates are: cultivated land - 31 tons/acre; forest land - 1 ton/acre; pastureland - 0.7 ton/acre; and urban-industrial land - 0.7 ton/acre.

Erosion damage caused by scouring on the flood plains is present in all reaches. Soil productivity on these areas is reduced 20 to 50 percent. Annual monetary damages are \$600 over 230 acres.

At the time of work plan development, approximately 400 acres were serious sediment sources in the watershed. Fifty acres of these were associated with road cuts and fills. These critically eroding areas are scattered throughout the watershed. Remaining to be stabilized are 20 acres associated with road cuts and fills and 60 acres on farms.

#### Sediment Damage

Overbank sediment deposition is moderate to severe in all reaches. Deposits of sterile sand occur throughout the flood plain. Depth of deposition ranges from a few inches in areas infrequently flooded to several feet near the stream channels. The channel capacities are reduced due to a moderate to heavy sand bedload. The stream water quality is reduced due to suspended sediment concentrations. Average annual suspended sediment concentrations at selected watershed locations are:

<u>Location</u>	<u>Suspended Sediment Concentration</u>
South Tyger River at entrance to Lake Cunningham	194 mg/l
Noe Creek, one-half mile east of Tigerville	199 mg/l
Meadow Fork Creek, two miles west of Tigerville	184 mg/l
Beaverdam Creek, three miles northwest of Lake Cunningham	410 mg/l

Sediment accumulation has reduced the productive capacity on 1,340 acres. Yields have been lowered 20 to 90 percent. The monetary damages average \$5,500 annually.

Without the project, accumulation of sediment in Lake Cunningham is reducing the reservoir storage 22 acre feet annually. This results in an annual value reduction of \$19,700 because of the high values associated with existing properties surrounding the lake and the



investment in the pumping station.

#### Municipal and Industrial Water

The Commission of Public Works, City of Greer, and the Blue Ridge Rural Water Company presently obtain their water from Lake Cunningham. Sediment accumulations have reduced the storage capacity of the reservoir. Because of this reduction of capacity and increased population and industrial growth, this reservoir will not supply the needs. Ground water aquifers in this area normally will not supply large quantities of water. Yields from most wells range from three to 25 gallons per minute.

The Greer area is experiencing rapid industrial growth. This rate of growth is expected to continue for the foreseeable future. The continued industrial growth and the accompanying urban development in the approximately 150 square mile service area of the two water distributing agencies will create a greater need for an expanded water supply. Enwright Associates, the engineering firm employed by the Commission of Public Works, City of Greer, has determined the projected needs to be eight million gallons per day by 1980 to serve an anticipated population of 57,000 and 32 million gallons per day by 2028 to serve an estimated population of 208,000.

#### Recreation

The Statewide Comprehensive Outdoor Recreation Plan identified a need for an additional recreation development in the watershed area. The estimated population within a 25 mile radius of the watershed is 400,000.

Hartwell Reservoir and Keowee-Toxaway (under development), Table Rock, Pleasant Ridge and Paris Mountain State Parks are within 50 miles of the watershed. Lake Cunningham is just below the watershed, but has no public facilities. Smaller lakes and parks are nearby, but the developments in the area currently have heavy usage and will not be able to satisfy the demands of the projected population of 510,000 in 1990, and 640,000 in 2020.

#### Economic and Social Problems

About 74 percent of the commercial farms are low producing units with annual sales of less than \$10,000. Farm incomes are lower, on the average, than nonfarm incomes. Underemployment of farmers due to small land holdings adds to the low income problem. Nonfarm employment is primarily in textile industries where wages are historically lower than other sections of the economy. According to U.S. Bureau of the Census data for 1970, 12 percent of all families, and 32 percent of all black families in the area had incomes below poverty level. Lower incomes throughout the region result in a lower tax base which affects the amount of revenue available for

education and other social programs.

### PROJECTS OF OTHER AGENCIES

There are no known projects which will adversely affect the works of improvement included in this plan. The structural and land treatment measures will reduce the amount of sediment now entering Lake Cunningham.

### PROJECT FORMULATION

An application for federal assistance through Public Law 566 was submitted by the sponsors of the South Tyger River Watershed on March 13, 1964. This application was processed, planning authorization granted, and a work plan was developed. This plan was approved for installation by the Agricultural Committees of Congress on February 23, 1967.

The structural measures included in the plan consist of five single purpose floodwater retarding structures, one multiple purpose structure for flood prevention and municipal water supply, and 15.03 miles of channel work. Three floodwater retarding structures and about two miles of channel work have been installed.

The sponsors have requested that the multiple purpose structure and remaining channel work be deleted. The Blue Ridge Rural Water Company will provide water for the town of Tigerville.

Lake Robinson, a multiple purpose structure for flood prevention, municipal and industrial water supply, and recreational water storage has been added to the plan. The Commission of Public Works, City of Greer, has been added as a sponsor.

The plan now includes five single purpose floodwater retarding structures, one multiple purpose structure, and two miles of channel work as structural measures to supplement the land treatment measures.

### Objectives

Objectives agreed to by the sponsors and the Service are: (1) apply needed land treatment measures, (2) stabilize critically eroding areas, (3) reduce floodwater damages, (4) create a dependable source of municipal and industrial water for the service area of the Commission of Public Works, City of Greer, and the Blue Ridge Rural Water Company, (5) provide additional water based recreational opportunities, and (6) reduce sediment being deposited in Lake Cunningham.

The project was developed in full cooperation and consultation with interested agencies and individuals. Public meetings were held throughout planning to review progress and recommendations of others.

Reports were prepared by the South Carolina Wildlife and Marine Resources Department, the U.S. Fish and Wildlife Service, the South Carolina Department of Parks, Recreation and Tourism and the Environmental Protection Agency.

Enwright Associates, Inc., developed information as to the need for water for municipal and industrial and recreation purposes.

The land treatment needs were developed from a field survey and include needs over that supplied by the going programs. The land treatment planned has been adjusted for expected landowner participation and installation period.

#### Environmental Considerations

In developing this plan, investigations were made as to the impact of the project on any environmental issue or concern that was identified. An investigation was made to determine archeological values by representatives of the Institute of Archeology and Anthropology, University of South Carolina.

Recreational facilities compatible with water quality and the health and safety of the user are necessary to realize the expected benefits.

The downstream effect on stream flow and quality of water has been analyzed to identify the impact and resulting changes to be expected.

The permanent commitment of resources was evaluated with each alternative considered. Losses of each resource were identified and evaluated in relation to the total amount of that resource.

The displacement of people, businesses, or farm operations because of structural measures was considered.

Methods of avoiding air, water, and noise pollution were included in project formulation.

#### Alternatives

The following alternatives were considered:

1. Accelerated land treatment. This alternative consists of those practices and measures described previously under the heading of "Planned Project - Land Treatment." Impacts from this alternative would be similar to those described for the land treatment portion of the proposed plan. Flood damages would be reduced approximately three percent. Adverse impacts resulting from the irreversible and irretrievable commitment of land to structural measures would be eliminated. Needs for additional municipal and industrial water supply and for increased water based public recreation opportunities would not be satisfied. Cost of this alternative is estimated to be \$300,000.



2. Land treatment, flood proofing, land use compatible with present flooding, and municipal and industrial water from other sources. This alternate would necessitate land use restrictions to minimize damages. There are no existing authorities to implement land use regulations in the watershed. The only reasonable use of the flood plain which would be compatible with existing flooding is forest land and some pasture. These uses would not be compatible with existing farm units or the economic needs of the area. The only fixed improvements involved are roads and bridges. Flood proofing would involve enlarging the bridge openings, raising or relocating roads, and/or riprapping. The engineering firm employed by the Commission of Public Works, City of Greer, considered six alternative sources of water outside the watershed and found them to be either impractical or unavailable. The cost of obtaining water from either of the sources considered far exceeded the proposed Lake Robinson cost. The cost of this alternative, not including water supply is estimated to be \$600,000 and would provide eight percent of the benefits from the planned project. Recreation needs would not be satisfied.
3. No project. With no project, the area will experience a serious shortage of municipal and industrial water, recreation needs will not be satisfied, sediment accumulation in Lake Cunningham will continue, and floodwater damages will remain.

#### WORKS OF IMPROVEMENT TO BE INSTALLED

##### Land Treatment Measures

The objectives of the South Tyger River Watershed are firmly tied to an intensive land treatment program which will reduce erosion and the rate of runoff. These measures are basic and must be properly installed and maintained if the project is to function as planned. The land treatment is based upon the findings obtained from standard soil surveys.

Conservation treatment systems will be installed on 1,200 acres of cropland scattered throughout the watershed during the project installation period reducing soil loss to within tolerable limits. At least two systems of treatment will be used. These systems are as follows:

System 1: A combination of terraces, grassed waterways, field borders, land leveling, stripcropping, contour farming, and conservation cropping systems.

System 2: A combination of grassed waterways, field borders, land leveling, contour farming, conservation cropping systems, and no-till planting.

All of the practices in System 1 and System 2 can be used together and with excellent results for conservation farming, but the land's capabilities will govern what practices should be employed and in what combination.

Other areas will receive partial treatment. About 150 acres of critically eroding cropland will receive special treatment during the installation period by the establishment of permanent grasses.

On pastureland, the major treatment system will include smoothing the land and pulling down and smoothing old terraces by special equipment, removal of undesirable forage and weeds by mechanical cutting and applying selected herbicides, planting improved grasses and legumes, and a balanced fertilization and liming program based on soil tests and treatment needs. Landowners using herbicides will be urged to follow the recommendations of the Clemson University Extension Service, a cooperating agency with the U.S. Department of Agriculture, and the regulations of the South Carolina Pesticide Control Act. Cross fencing will be installed where deemed necessary. During the installation period, an estimated 1,500 acres of pastureland will be adequately treated and additional areas will receive partial treatment.

On forest land, conservation practices will be installed that will improve hydrologic conditions. By manipulating stand compositions that create favorable conditions for the maximum production and protection of litter and humus, a protective cover and an absorbent forest floor will develop.

Measures that create these favorable conditions include tree planting, timber stand improvement, thinnings, and protection of the forest floor from livestock grazing and wild fires.

To provide for proper installation and maintenance of these measures, forest management plans will be prepared and included as a part of conservation plans.

Forest measures to be installed during the installation period include 1,000 acres of hydrologic stand improvement and the stabilization of 200 acres of critically eroding forest land.

Special treatment, such as sloping roadbanks, mulching, and establishing grasses will be provided to stabilize 50 acres of critically eroding county roads.

Technical assistance furnished by the Soil Conservation Service and the South Carolina State Commission of Forestry, through its cooperative program, will play a major role in the application of land treatment measures. Most of the land treatment measures will be applied on private land by the landowner or operator through voluntary agreement with the soil and water conservation district. These measures are for reducing erosion, runoff, and sediment movement. After the original work



plan was approved, the accelerated land treatment program began and about 80 percent of the planned measures have been applied. Areas remaining to be treated include 200 acres of cropland, 300 acres of pastureland, 300 acres of forest land, and 80 acres of critically eroding areas.

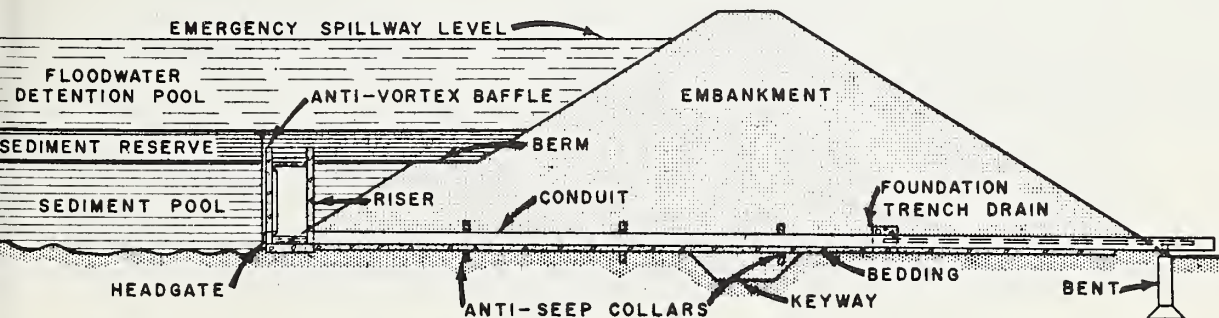
### Structural Measures

Three floodwater retarding structures (Sites 2, 4, and 5) and the channel work on Peck and Meadow Creeks have been installed. Installation costs of all structural measures are estimated to be \$6,302,600. Structural measures yet to be installed include two floodwater retarding structures (Sites 3D and 6A), one multiple purpose structure (Lake Robinson), and recreation facilities. The locations of structural measures are shown on the Project Map.

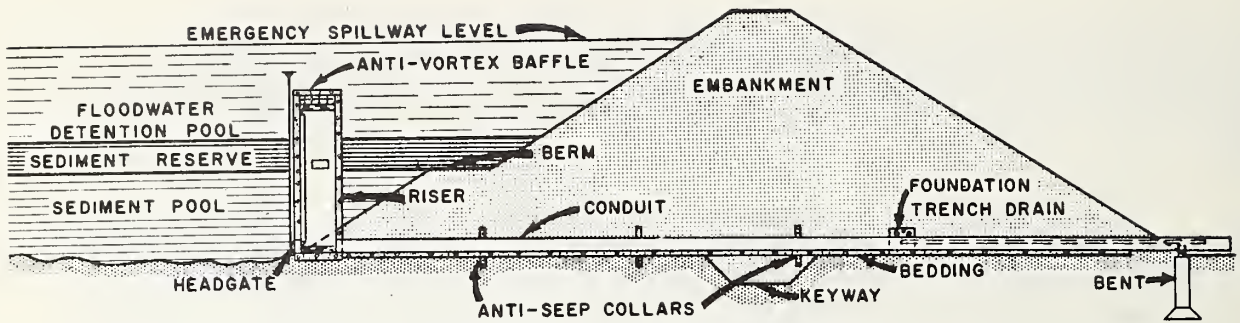
The drainage area above all structures is 34,929 acres and is 91.5 percent of the watershed. The drainage areas above structures are:

Structure 2	-	1,792 acres
Structure 3D	-	4,922 acres
Structure 4	-	1,767 acres
Structure 5	-	1,798 acres
Structure 6A	-	3,411 acres
Lake Robinson	-	31,518 acres

Structures 2, 4, and 5 provide 1,506 acre feet of floodwater detention and 294 acre feet for sediment accumulation. Structures 3D and 6A will provide 2,530 acre feet of floodwater detention and 640 acre feet for sediment accumulation. The structures are designed for an effective life of 100 years. These structures consist of earthfill embankments and reinforced concrete principal spillways located on yielding foundations. Structure 2 is 29 feet high and 424 feet long; Structure 4 is 28 feet high and 665 feet long; and Structure 5 is 43 feet high and 628 feet long. Structure 3D will be about 43 feet high and approximately 570 feet long. Structure 6A will be about 31 feet high and approximately 640 feet long.



TYPICAL SECTION OF FLOODWATER RETARDING STRUCTURE, WITH SINGLE STAGE RISER



TYPICAL SECTION OF FLOODWATER RETARDING STRUCTURE, WITH TWO STAGE RISER

Principal spillways consist of reinforced concrete risers on the upstream side of the structures with reinforced concrete pipes, fitted with anti-seep collars, placed through the embankments. Structure 3D has a single stage riser, and Structures 2, 4, 5, and 6A have two-stage risers. The crest of the principal spillway of Structure 3D and the crest of the low stage inlet of Structure 6A will be set at the 50 year sediment accumulation elevation. The crest of the low stage of the principal spillway riser for Structure 5 was constructed at the 50 year sediment accumulation elevation and for Structures 2 and 4 was constructed at the 100 year sediment accumulation elevation. The principal spillways outlet into deep excavated plunge basins at the end of the principal spillway pipes. Water flowing through the principal spillway plunges down into the pool dissipating much of its erosive energy.

The emergency spillways will be constructed in earth and vegetated. The crest elevations for the spillways of Sites 3D and 6A will be set at the 50 year frequency level and will have a two percent chance of operation in any year. The percent chance of operation of the emergency spillways for Structures 4 and 5 is four percent and for Structure 2 is two percent.

The Lake Robinson structure will include storage for 855 acre feet of sediment, 734 acre feet of recreation water, and 12,811 acre feet for municipal and industrial water. The minimum surface area of the recreation pool will be 250 acres. The surface area of the water supply pool will be 800 acres. Reservoir operation studies of Lake Robinson using rainfall and runoff records for the years 1952 through 1956 were made to determine the yield. The drought of 1954 is one of the most critical on record for this area. The only other drought of this magnitude on record occurred in 1925.

The following table shows demand and minimum surface areas during a drought comparable to the one in 1954 for Lake Robinson:

<u>Demand</u> (mgd)	<u>Minimum Surface Area</u> (Acres)
5	787
10	760
15	715
20	653
25	570
30	468
35	295

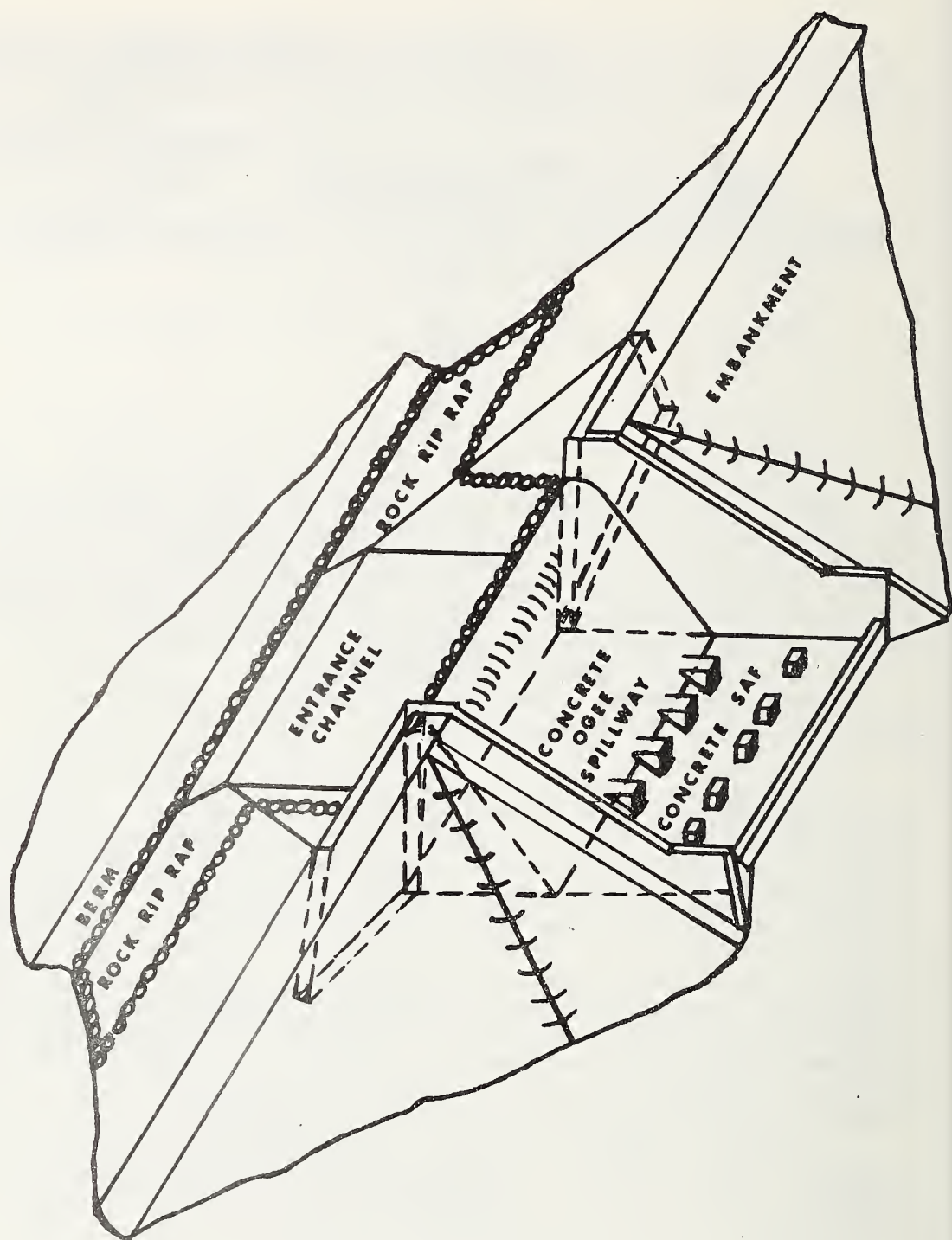
Even during a drought the pool fluctuation will be minor until the demand exceeds ten million gallons per day (mgd), which would occur in the fall or winter months. During normal years, the 32 mgd demand would reduce the surface from 800 acres to 595 acres. Enwright Associates have projected the need for 32 mgd to occur in the year 2028. They have projected the demand to be 8.7 mgd by 1980, 10.5 mgd by 1987, and 14.5 mgd by the year 2000.

Maximum elevations of pools are as follows: sediment pool - 860.0, recreation pool - 863.5, M&I pool - 889.0, and top of dam - 914.0.

The structure will consist of an earthfill embankment 77 feet high with a 90 foot concrete ogee spillway. The spillway crest will be set at the maximum surface elevation of the water supply pool. The spillway will outlet into a Saint Anthony Falls (SAF) type, energy dissipating basin. This basin creates a hydraulic jump (a turbulent, rapid rise in the water surface) which dissipates much of the water's erosive energy within the reinforced concrete structure. The concrete ogee spillway and SAF basin will be located on a non-yielding rock foundation. The upstream face of the earth embankment portion of the structure and the entrance channel to the ogee spillway will be riprapped over the area subject to wave action. A chimney drain for the non-concrete portion of the dam will be installed to reduce the potential for damage in the event of an earthquake.

A reinforced concrete riser will be constructed upstream from the ogee spillway and will be connected to the ogee spillway by a reinforced concrete pipe. A culvert opening will be voided through the ogee spillway section to allow the discharge flowing through the riser system to outlet on the downstream side of the ogee spillway. A headgate will be installed at the bottom of the riser to allow the reservoir level to be lowered for maintenance of the structure. Two gates will be installed on the riser to release M&I water downstream to Lake Cunningham where the Commission of Public Works, City of





LAKE ROBINSON  
MULTIPLE PURPOSE STRUCTURE

Greer has its municipal water treatment facilities.

A dike approximately 820 feet long and 27 feet high will be constructed across a low saddle adjacent to the hill forming the right abutment. Its upstream face subject to wave action will be riprapped.

The channel banks below the SAF outlet will be riprapped for a distance of about 400 feet to prevent channel bank erosion. The ogee spillway and SAF outlet will be fenced to control access.

Material for all embankments will be obtained from areas near the structures or from excavated emergency spillways. Most of the borrow needed will be obtained from areas below the top of dam elevation.

The sediment pools of the structures will initially be filled with water but will gradually be replaced with sediment during the 100 year life of the reservoirs. The sediment pools of Sites 3D and 6A and the normal pool of Lake Robinson plus a strip 15 feet horizontally from the water's edge will be cleared of woody vegetation. The construction areas for structure embankments, emergency spillways, and borrow areas will be cleared and grubbed. A strip covered by the top 10 feet of M&I water in Lake Robinson will be grubbed to improve initial water quality. The total area to be cleared is 931 acres, consisting of 719 acres of forest and 212 acres of openland.

Vegetation suitable to the soils, site conditions, and intended uses will be established on the embankments, exposed borrow areas, and earth spillways. Plant species and the method of establishment will be specified in a vegetation plan prepared for each structure. Varieties of vegetation favorable to wildlife will be established in the borrow areas above the normal pools. The cleared strip along the edge of the pools will revegetate naturally.

Easements will be obtained to the top of dam elevation at Sites 3D and 6A and will include 313 acres. The installation of Lake Robinson will require land rights to be obtained on 1,623 acres. Fee title will be obtained on 1,146 acres and flowage easements will be obtained on 477 acres. (See Public Recreation Development Map.) The land to be purchased includes 800 acres for the normal pool and the remainder for the recreation development area, the construction area, and the recreation access strip around the normal pool.

The recreation area planned in conjunction with Lake Robinson will be located adjacent to the right abutment of the structure and will be accessible by paved road from State Highways 92 and 101. Recreation facilities and full public access will be provided. The recreation development will be in accord with the statewide plan. Facilities are shown on the Public Recreation Development Area Map and are listed in Table 2B.

Recreation facilities will include paved access roads, parking areas for cars and boat trailers, boat ramps, picnic tables, cast iron grills, underground waste receptacle units, picnic shelters, foot trails, and comfort stations. Plans for the recreation facilities are preliminary and may vary slightly in final design.

Paved roads and the car-boat parking areas in the recreation



area will consist of one and one-half inches of asphaltic surface over a four inch crushed stone base. The width of the paved road surface will be 22 feet. The parking area for picnickers will be surfaced with four inches of crushed stone. All roads and parking areas will generally follow the contour. Grasses and/or legumes will be established on all cuts and fills. Drainage will be provided by collection ditches and culverts, where necessary.

The boat launching ramps will be constructed of reinforced concrete logs.

Picnic tables will be constructed with reinforced concrete uprights with wooden seats and table tops. Wooden picnic shelters will be approximately 20' x 40' with a concrete floor.

Two four unit (2+2) flush type comfort stations will be located in the recreation area. Septic tanks with disposal fields will be used to treat wastes. All sanitary facilities will be approved by appropriate federal, state, and local health authorities prior to installation.

To provide water for the comfort stations and hydrants, a connection will be made to the existing water distribution system of Blue Ridge Rural Water Company. Hydrants will be located adjacent to parking areas and boat launching ramps.

Foot trails will be constructed five feet wide and will be graded to provide a good hiking surface.

Electrical distribution lines will be installed to provide power to comfort stations and lighting for parking areas.

Signs for identification and directions and gates to control access will be installed. The area will be landscaped as appropriate.

The facilities will be designed and constructed to assure accessibility and usability by the physically handicapped in accordance with Public Law 90-480.

All planned structural measures will meet the requirements of local and state health laws. None of the single purpose floodwater retarding structures will be available to the public for any recreation activities. Unless adequate sanitary facilities are provided, the sponsors will discourage the use of these structures for public recreation. All of the structures have a potential for public use.

Land areas to be committed to structural measures, are summarized as follows:

	Forest land	Openland	Total
	(acres)		
<u>Site 3D</u>			
Sediment Pool	9	4	13
Maximum Reservoir Area <u>1/</u>	30	160	190
Construction Area	6	0	6
<u>Site 6A</u>			
Sediment Pool	37	3	40
Maximum Reservoir Area <u>1/</u>	95	17	112
Construction Area	5	0	5
<u>Lake John A. Robinson</u>			
Sediment Pool	140	25	165
Recreation Pool <u>2/</u>	205	45	250
M&I Pool <u>2/</u>	617	183	800
Maximum Reservoir Area <u>1/</u>	1,206	375	1,581
Construction Area	15	10	25
Purchase Area <u>3/</u>	864	282	1,146
Recreation Development Area <u>4/</u>	13	12	25
<u>Total Area Committed for</u>			
Remaining Work	1,366	570	1,936

The Greenville County Recreation Commission plans to study the feasibility of establishing a primitive recreation park near the upstream end of Lake Robinson. This would provide additional access for recreation.

During construction, the following actions will be taken to control erosion and pollution:

- a. Sprinkling will be used to keep dust in construction areas within acceptable limits.

- 1/ Pool area at top of dam elevation.
- 2/ Pool areas are cumulative.
- 3/ Includes recreation development area, normal pool, structure, borrow areas and the recreation access strip around the normal pool.
- 4/ Eight acres are within the maximum reservoir area.

- b. Sanitary facilities will be provided in accordance with the requirements of the South Carolina Department of Health and Environmental Control.
- c. Precautions will be taken at equipment and repair areas to prevent contaminants from reaching streams and ground water to comply with Public Law 92-500 and the South Carolina Pollution Control Act.
- d. All operations will be conducted to minimize stream turbidity at and below the structures. Requirements established by the South Carolina Department of Health and Environmental Control will be adhered to during construction. The following erosion and sediment control measures will be applied as needed to the area of land which will be exposed:
  - (1) the contract will include earthmoving equipment time to construct diversions, waterways, and terraces as needed to retard the rate of runoff and control runoff from the construction site;
  - (2) debris basins will be used to minimize sediment leaving the construction site where needed;
  - (3) clearing and grubbing of construction sites and borrow areas will occur in stages as construction progresses;
  - (4) temporary vegetation and/or mulching will be used to protect the soils; segments of work will be completed and protected as rapidly as is consistent with construction schedules; and
  - (5) conduits or bridges will be installed where construction activities cross flowing streams.
- e. Prior to construction, areas will be designated for the disposal of waste material. All debris will be disposed of in accordance with regulations of the South Carolina Department of Health and Environmental Control. The landowners of the area to be cleared will be given the opportunity to salvage trees prior to the beginning of construction.
- f. Vector control will be mutually agreed upon by the Soil Conservation Service, the local sponsors, and the South Carolina Department of Health and Environmental Control.



Included in changes to fixed improvements needed to install the project are road and bridge relocations on three county roads within the reservoir of Structure 3D, two paved and one unpaved. Three buildings and one well are within the minimum easement area of Site 6A. The buildings will be moved or demolished and the well will be protected from contamination. State Highway 140, located at the upper end of Site 6A, lies below the elevation of the emergency spillway crest and will be raised.

Several changes to fixed improvements are needed at Lake Robinson. Mays Bridge and the western end of Mays Bridge Road are located where the structure and the dike will be constructed and will be removed. A new bridge and road will be constructed downstream from the structure to maintain the road connection between State Highways 92 and 101.

Fews Bridge on State Highway 113 and Tyger Bridge on State Highway 114, crossing Lake Robinson, will be raised to allow boats 11 feet of clearance above the normal pool elevation. The abandoned bridge near Fews Bridge will be removed.

Pennington Road, crossing a tributary of the reservoir at a point approximately 0.7 miles north of Mays Bridge, will be raised about eight feet to elevation 902.0. A county road crossing Wildcat Creek, one-quarter mile northeast of Tyger Bridge, will be raised about four feet to elevation 902.0.

When Fews Bridge is raised, a telephone cable and water line attached to the bridge will be raised. Approximately one mile of power lines located in the reservoir will be removed. These lines are located along the western end of Mays Bridge Road and along other roads which serve buildings to be demolished.

Three farm ponds are located within the reservoir area, but only one will be inundated by the normal pool. This pond is located about one-quarter mile north of West Road. Ponders and Fews Lakes have approximate top of dam elevations of 905.0 and 897.0, respectively.

Two dwellings and 11 storage buildings and/or barns have first floor elevations below elevation 899.1, the maximum elevation of the reservoir during the emergency spillway design storm. These buildings will be demolished or removed from the reservoir area. Five dwellings and six storage buildings and/or barns have first floor elevations between 899.1 and 914.0, the top of dam elevation. The first floor of the dwellings are all above elevation 909.0. The top of dam elevation is based on the structure's spillway conveying safely the runoff from the probable maximum eight hour storm. Since the probability of the reservoir filling above elevation 900.0 is so small, the sponsors plan to obtain flooding easements on the dwellings, barns and storage buildings, and other fixed improvements in this area instead of moving or demolishing them. The sponsors are aware that they are responsible for damages caused by floodwater inundating property within the reservoir created by the dam and will obtain the necessary land rights to protect themselves.

The project will comply with the Historic and Archeological

Data Preservation Act, Public Law 93-291, and the Historic Properties Preservation Program, Public Law 89-665 (Section 106). It will also comply with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894).

### EXPLANATION OF INSTALLATION COSTS

Land treatment measures already applied and to be applied during the project installation period are estimated to cost \$424,700. This total includes the costs of establishing land treatment practices by individual landowners, treatment of critically eroding areas, and technical assistance. About 80 percent of the planned land treatment has been established.

Three floodwater retarding structures and two miles of channel work have been installed. The cost of this work was \$460,800, including construction, land rights, engineering, and project administration.

The remaining structural measures are two floodwater retarding structures, one multiple purpose structure, and recreation facilities. These measures are estimated to cost \$5,841,800 and consist of construction, engineering services, project administration and land rights.

Construction costs are the estimated cost of all materials and labor necessary for construction. These costs, estimated to be \$3,417,000, were determined for each structure by estimating the quantities required for construction and applying unit costs based on previously constructed projects. Included in the construction cost is a 15 percent contingency allowance to cover unforeseen items that may be encountered during construction.

Engineering services costs are estimated to be \$236,000 and consist of the costs of design surveys, geological investigations, design, and preparation of plans and specifications for the structural measures.

Project administration costs, estimated to be \$262,800 consist of costs associated with the installation of structural measures. These include cost of contract administration, review of engineering plans prepared by others, government representatives, construction surveys, inspections during construction, relocation advisory assistance, and other similar costs.

Land rights include land easement values, the value of land to be purchased, land surveys, appraisals, legal fees, options, raising roads and bridges, removing buildings, relocating pipelines and utilities, and any other costs associated with rights-of-way. These costs are estimated to be \$1,924,600. In connection with the multiple purpose structure, Lake Robinson, which incorporates capacity for municipal water, recreation, and flood prevention (sediment storage), all costs of fee title land rights, including modification of existing improvements were allocated between municipal water supply and recreation. The percentage allocated to recreation was determined on the basis of the



total land area required for the dam and reservoir minus the reservoir area for municipal water and divided by the total area for the dam and reservoir. The remainder was allocated to municipal water supply. The land area for installing recreation facilities was excluded when allocating the cost of modification of improvements.

Costs of the two floodwater retarding structures were allocated to flood prevention. Costs of Lake Robinson were allocated to flood prevention, municipal and industrial water, and recreation by the Specific Costs-Remaining Benefits method. Costs of Lake Robinson were designated as specific costs or joint costs. Specific costs include all land rights, grubbing part of the M&I pool, M&I water release gates, recreation development construction costs, operation and maintenance, replacement of the recreation facilities, and engineering costs for the release gates, grubbing part of the M&I pool, and the recreation development. All other costs were determined to be joint costs and were allocated as follows: 9.6 percent flood prevention, 60.6 percent M&I water, and 29.8 percent recreation. Project administration costs were not allocated.

Costs will be shared by PL-566 funds and other funds as follows:

1. Construction costs allocated to flood prevention will be paid by PL-566 funds. Construction costs allocated to recreation will be shared equally between PL-566 and other funds. Construction costs allocated to municipal and industrial water will be paid by other funds.
2. Engineering services costs allocated to flood prevention will be paid by PL-566 funds. Engineering services costs allocated to municipal and industrial water will be paid by other funds. Engineering services costs associated with Lake Robinson which are allocated to recreation will be paid by PL-566 funds. Engineering services costs of the recreation facilities will be shared equally by PL-566 funds and other funds.
3. Land rights costs allocated to flood prevention and municipal and industrial water will be paid by other funds. Land rights costs for land purchase and alteration of fixed improvements which are allocated to recreation will be shared equally by PL-566 funds and other funds. All legal fees, appraisals, and costs of options will be paid by other funds.
4. Relocation costs associated with persons, farms, and businesses will be shared by PL-566 and other funds, 60.6 percent and 39.4 percent, respectively. This rate was determined by the total project cost of the original Watershed Work Plan (Table 1, dated May 1966). All

relocation assistance advisory services will be paid by other funds.

5. The Service and the sponsors will each bear the costs of project administration which it incurs.

Total structural measures costs amount to \$5,841,800 and will be shared by PL-566 and other funds, \$1,793,000 and \$4,048,800, respectively.

Estimated expenditures for structural measures and land treatment by years are as follows:

Project Year	PL-566 Funds		Other Funds	
	Structural Measures	Land Treatment	Structural Measures	Land Treatment
To Date	\$ 361,700	\$65,000	\$ 99,100	\$240,000
First	437,600	6,500	1,540,700	19,000
Second	275,700	6,000	127,200	19,000
Third	421,000	6,000	760,000	19,000
Fourth	549,800	6,000	1,542,600	19,000
Fifth	108,900	6,000	78,300	13,200
TOTAL	\$2,154,700	\$95,500	\$4,147,900	\$329,200

#### EFFECTS OF WORKS OF IMPROVEMENT

##### Flood Prevention, Erosion, and Sediment

The installation of project measures will reduce floodwater damages by an average of 88 percent. The level of protection provided will be adequate for truck crops near the floodwater retarding structures and for pastures in the downstream reaches. Sediment yield to Lake Cunningham will be reduced from 22 to two acre feet per year. (Structures already installed have reduced this yield to 17 acre feet annually.) This will greatly increase the life of Lake Cunningham, for M&I water storage and residential lots. Damages by sediment deposition on flood plain land will be reduced by about 87 percent.

Present land use in the benefited area is as follows: 225 acres of pasture and 726 acres of trees and brush. After the project is installed, land use is expected to be 412 acres of pasture, 113 acres of crops, and 426 acres of forest. Structural measures will benefit 85 family farms, most of which are low-income producing units. The project will encourage these farmers to make land use adjustments that will improve family income. Upland erosion on cultivated land will

be reduced 30 percent (9 tons per acre) by the installation of land treatment practices and changes in land use. Erosion of flood plains will be reduced by the construction of the floodwater retarding structures.

#### Water Supply

Water stored in Lake Robinson will serve a population of 200,000 people within the next 50 years. An estimated sustained yield of 32 million gallons per day, will be used by residences, businesses, and industries in the service area of the Commission of Public Works, City of Greer, and the Blue Ridge Rural Water Company. Additional jobs will be created by expanding industrial and commercial development.

#### Fish and Wildlife and Recreation

Forest wildlife habitat will be changed to crops or pasture type habitat by clearing of 300 acres. Construction of the reservoirs and recreation facilities will require clearing of 719 acres of forest wildlife habitat and permanently inundate 853 acres. In addition, 1,030 acres will be designated as flood pools and will be periodically inundated as floodwater is temporarily stored. About 6.3 miles of stream fishery will be lost.

The reservoirs will create waterfowl habitat. The edges of the lakes will provide about 23.5 miles of shoreline habitat favorable for herons, egrets, and shorebirds which are now absent or limited in numbers. These species can be expected to migrate through or, even reside, in the watershed. Wood duck populations will increase with the creation of rearing and brooding habitat. As sediment accumulates in the reservoirs, more marsh habitat will be created.

The project will create 853 acres of lake fishery. The 800 acre multiple purpose lake will have the potential to produce high yields of game fish such as bream and bass.

Planting of wildlife food and cover crops in power line rights-of-way, field borders, and open areas in woods will improve wildlife habitat, especially for birds and other small animals. Stabilization of critically eroding areas will improve wildlife habitat.

Water stored in Lake Robinson for recreation and the recreation facilities will increase the opportunities for recreational use. The activities will include fishing, picnicking, boating, sight-seeing, hiking, and similar activities. Facilities will have a design capacity of 375 visitors. The average annual use of the recreational facilities is estimated to be 53,000 visitor days. The value of a visitor day is estimated to be \$2.00.

Water temperature will be increased because of the increased water surface exposure. This will result in a maximum temperature increase of five degrees Fahrenheit downstream. Evaporation losses will also be greater.



### Archeological, Historic, and Scientific

A review of the proposed project with the South Carolina Department of Archives and History, Historic Preservation Section, revealed that no historic place would be affected.

The Institute of Archeology and Anthropology, University of South Carolina has made a field survey of all construction sites and areas to be permanently flooded. No archeological sites were located in these areas. A detailed report has been prepared by the Institute of Archeology and Anthropology. Should any artifact or other scientific value be uncovered during construction, the Institute of Archeology and Anthropology and the National Park Service will be notified.

The proposed construction will not affect any unique scientific landscape features, nor will it change the existing responsibility of any federal agency under Executive Order 11593 with respect to archeological and historic resources.

### Economic and Social

Employment opportunities will be increased as a result of the project. Unemployed and underemployed persons will have more opportunities to find jobs or to be more fully employed. Some underemployed farmers will be better able to utilize flood plain land for more efficient farming operations. An ample supply of municipal and industrial water will encourage present industries and businesses to expand their operations and will encourage other industries to locate in the community. The planned project will create six permanent skilled jobs, 45 permanent semi-skilled jobs, 21 skilled jobs for one year and 148 semi-skilled jobs for one year. The regional income benefit from the project is \$355,200. It is estimated that this income will be distributed as follows:

<u>Income Class</u>	<u>Percentage of Adjusted Gross Income in Class</u>	<u>Percentage Benefits in Class</u>
Less than \$4,000	16	20
\$4,000-\$10,000	43	43
More than \$10,000	41	37



Local costs of \$159,300 will be distributed as follows:

<u>Income Class</u>	<u>Percentage of Adjusted Gross Income in Class</u>	<u>Percentage Contribution in Class</u>
Less than \$4,000	16	20
\$4,000-\$10,000	43	40
More than \$10,000	41	50

According to U.S. Bureau of the Census data for 1970, 12 percent of all families, and 32 percent of all black families in the area had incomes below poverty level. As the tables above show, installation of the planned project will redistribute income from the higher to the lower income class.

Local secondary benefits in the form of increased business from transporting additional supplies and products and other business activity will accrue to residents of the community.

The proposed recreation area will provide an opportunity for supportive enterprises to develop. Job opportunities and other economic benefits will result from commercial growth on private land surrounding the area.

The increases in population, industries, business activities, and travel in the area will increase the burden of waste disposal and other adverse effects associated with a greater number of people. Increased road maintenance may be required due to increased traffic on the areas roads.

The increased traffic resulting from the recreational use of Lake Robinson will have little effect on noise levels around the reservoir. Peak use during the summer will be approximately 750 persons per day and will increase traffic by about 250 cars per day. The area where Lake Robinson will be constructed is considered rural and any increase in traffic should have little impact on residents of the area. An investigation of the area around Lake Robinson revealed no rest homes, hospitals, or other noise-sensitive sites are located near the site of the reservoir.

Expanded business, new homes, and enhanced land values will tend to improve the tax base, thereby providing more funds for education and other social functions in the community.

Two families will be relocated and will incur the inconvenience of moving as a result of land acquisition.

The land treatment measures for forest land will improve the hydrologic condition of the forest soils, thus improving the soil's ability to absorb rainfall. As more water is absorbed by the soil, less will flow overland, erosion will be reduced, sediment in the streams will be reduced, and flooding will be less often and less

severe.

The proposed Lake Robinson will inundate 582 acres of bottom land forest types, which is about half of bottom land hardwoods in the watershed. The soils within this area of forest land, the potential productivity class and potential cubic foot volume of growth per acre per year, and acreage is as follows:

<u>Soil Type</u>	<u>Potential Productivity</u>		<u>Acreage</u>
	<u>Class</u>	<u>Cu.Ft. Vol./Ac./Yr.</u>	
Cartecay-Chewacla	Very high	130 cu.ft.	455
Cartecay-Toccoa	High	110 cu.ft.	112
Wehadkee	Very high	140 cu.ft.	15

The potential annual growth on this area is about 76,200 cubic feet. This volume could be achieved with either pine or hardwood by applying sound management practices, by reducing sediment deposits and by eliminating flooding. Present annual growth of commercial species within this same area is approximately 18,500 cubic feet.

There are 617 acres of forest that will be inundated, and 31 acres of forest will be lost due to the construction of the dam, spillways, borrow areas, etc.

Upon completion of the lake, construction of home sites around the lake, fishing facilities, recreation facilities and related transportation facilities will reduce forest acreage even more.

Approximately 648 acres of wildlife habitat will be lost to certain wildlife species associated with wet bottom lands, such as beaver, muskrat, etc. Present populations of these species are low.

Overall, wildlife habitat will be affected very little since about 75 percent of the forests in the watershed are classed as oak-hickory or oak-pine types.

#### Other

A total of 1,936 acres of land will be committed to the structural measures which includes the recreation development. This land will be restricted to specific use as follows:

	<u>Forest Land</u>	<u>Open Land</u>	<u>Water Area</u>	<u>Total</u>
Without Project	1,370	536	30	1,936
With Project	693*	390*	853	1,936

\*or uses compatible with infrequent inundation and recreation

Of the 1,936 acres, there are 1,146 committed to recreation. There are 1,030 acres subject to infrequent inundation by storage of floodwaters of which 22 percent is flood plain presently subject to inundation. Only 422 of the 1,030 acres will be inundated by a flood having a recurrence interval of once in 100 years. The remaining 608 acres will be inundated less frequently.

The agricultural and wildlife values will be reduced or lost because of the changed and restricted use of the area. Installation of the structures will inundate 6.3 miles of stream channel.

### PROJECT BENEFITS

Damage reduction benefits to crops and pastures amounts to \$10,200 annually. This benefit includes \$5,800 for restoration to former productivity. Other agricultural damage reduction benefits such as reduced flood damage to farm roads, equipment, fences, and livestock amount to \$1,100 annually. Nonagricultural floodwater damage reduction benefits total \$9,000 per year and are mostly from reduced floodwater damages to roads and bridges. Annual sediment reduction benefits are \$4,800 by reduction of overbank deposition and \$17,700 from the reduction of sediment in Lake Cunningham. Flood plain scour damage reduction benefits are \$500. Indirect flood damage reduction benefits are estimated to be \$3,500 per year (Table 5).

More intensive land use benefits are estimated to be \$12,700 per year. Benefits from municipal water will be \$145,500 and recreation benefits will be \$106,000 annually.

The value of local secondary benefits that will accrue in the region due to project installation will amount to \$18,500 annually. The value of local secondary benefits from a national viewpoint were not considered in the economic evaluation or justification of the project. Redevelopment benefits are estimated to be \$27,500 per year (Table 6).

Land treatment practices to be installed will result in benefits such as reduced erosion, lower sediment yields, greater productivity and maintenance of the soil resource and beautification of the countryside. Forest land treatment measures and fire control will improve the hydrologic condition and productivity of the forest land. Fishery resources will be improved by the project.



## COMPARISON OF BENEFITS AND COSTS

The average annual cost of structural measures, including project installation, project administration, and operation and maintenance, is estimated to be \$231,300. These measures are expected to produce benefits of \$355,000 annually. The ratio of average annual benefits to average annual costs is 1.5 to 1. The ratio of benefits to costs without local secondary benefits is 1.4 to 1.

## PROJECT INSTALLATION

The remaining land treatment measures will be established by landowners through cooperative agreements with the Greenville County Soil and Water Conservation District. The Soil Conservation Service and the South Carolina State Commission of Forestry, in cooperation with U.S. Forest Service, will assist landowners in planning and applying land treatment measures consistent with the authorities and capabilities of each agency. When landowners or operators desire assistance from other agency or private consultant, they will be referred to the appropriate agency or consultant.

The Greenville County Soil and Water Conservation District will be responsible for stabilizing critically eroding areas. Critical areas will be stabilized using the following division of work: for tree planting, the district will furnish trees and mulch and construct fences, and the Service will provide funds through the South Carolina State Commission of Forestry, in cooperation with U.S. Forest Service, for building brush dams and planting trees; for treating areas in fields, the Service will furnish materials and establish vegetation; and the district will prepare the sites and construct fences; for roadside treatment, the Service will furnish materials and the district will establish vegetation. These agencies will furnish technical assistance for critical area stabilization. The value of the work which the Service is to perform does not exceed cost sharing rates for such practices applicable under other going programs.

The sponsors have requested that the Soil Conservation Service administer the contracts for Structures 3D and 6A. Contracts for Lake Robinson and the recreational development will be administered by the Commission of Public Works, City of Greer.

The South Tyger River Watershed Conservation District will be responsible for land rights associated with Structures 3D and 6A. The Commission will be responsible for acquiring land rights for Lake Robinson and the recreational development. The District and the Commission have sufficient legal authority (including the power of eminent domain) and funds and agree to use such authority and funds, if necessary, to acquire land rights for the project. Prior to the purchase



of any land or land rights, the sponsors will be responsible for having an appraisal made by a qualified land appraiser.

Engineering services for Lake Robinson and the recreational development will be obtained through a negotiated contract with a private engineering firm agreed to by the Commission of Public Works, City of Greer, and the Soil Conservation Service. The Service will furnish engineering services for Structures 3D and 6A.

The Commission of Public Works, City of Greer, as part of project administration, will (1) provide by first class mail written notice of displacement and appropriate application forms for each displaced person, (2) assist in filing applications, (3) review and take action on applications for relocation assistance, (4) review and process grievances in connection with displacements, and (5) make relocation payments. The Service, as part of project administration, will assist the Commission in fulfilling these responsibilities.

The Commission will provide, without PL-566 financial assistance, such relocation assistance advisory services as may be needed in connection with the relocation of displaced persons.

The Commission has determined that decent, safe and sanitary replacement housing will be available for all persons subject to displacement by the project. Displaced persons will be given notice to vacate at least 90 days before they have to move.

Planned installation of structural measures over the five year installation period is as follows:

First year - secure all land rights needed for the project and investigate and design Structure 3D

Second year - construct Structure 3D, investigate and design Structure 6A and Lake Robinson

Third year - construct Structure 6A and start construction of Lake Robinson

Fourth year - complete construction of Lake Robinson and design recreational development; and

Fifth year - construct recreational development

The installation schedule of these planned measures may change as deemed necessary, except that Lake Robinson must be built after or concurrently with Structure 3D.

Prior to construction of each structure, the National Park Service, the State Archeologist and the State Liaison Officer for Historic

Preservation will be notified so that they can provide the necessary protection or salvage of any items of archeological or historical value that are revealed.

Prior to the Service providing financial assistance, the following conditions must be met: (1) the sponsoring local organization will have executed a specific operation and maintenance agreement, (2) the sponsors must be prepared to discharge their responsibilities, (3) adequate land treatment must be applied on 75 percent of those sediment source areas, which, if uncontrolled, would materially increase the cost of construction, operation, or maintenance of the structural measure, and (4) the Greenville Soil and Water Conservation District will obtain agreements with landowners to carry out soil and water conservation plans on at least 50 percent of the area above each structure.

### FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the works of improvement described in this plan will be provided under authority of the Watershed Protection and Flood Prevention Act (PL-566), as amended. Financial and other assistance to be furnished by the Service in carrying out the plan is contingent upon the availability of funds for this purpose. Program income (gross income earned by the sponsors as a result of grant-supported activities) shall be handled in accordance with instructions in Section 2000 of the Administrative Services Handbook.

The Commission of Public Works, City of Greer, has analyzed its financial needs in consideration of the scheduled installation and has determined that funds will be available when needed. The Commission has raised \$1,225,000 for land purchase at Lake Robinson by selling revenue bonds. The Commission expects to receive a grant for \$500,000 from the Appalachian Regional Commission. Negotiations are underway between the Commission and the Farmers Home Administration, including the filing of a preliminary application, for a loan to pay the remaining non-federal share of Lake Robinson and the recreational development. The estimated amount of the loan needed is \$2,200,000. Funds for repayment of the bonds and the Farmers Home Administration loan will be obtained through revenue from the combined utilities of the Commission of Public Works, City of Greer. The Commission sells to its customers water, gas, and electricity and operates the sewage treatment system. Prior to entering into agreements that obligate funds of the Service, the Commission of Public Works, City of Greer, will have a financial management system for control, accountability, and disclosure of PL-566 funds received, and for control and accountability for property and other assets purchased with PL-566 funds. Program income earned during the grant period will be reported on the sponsor's request for advance or reimbursement from the Service.

The directors of the South Tyger River Watershed Conservation District expect all land rights for Structures 3D and 6A to be donated. Where land rights are purchased, regulations of the Uniform Relocation Assistance and Real Property Acquisition Act of 1970 (Public Law 91-646, 84 Stat. 1894), will be followed.

The Commission will be responsible for road and bridge alterations, but will seek assistance from the county and state highway departments.

The local share of relocation payments, all relocation assistance advisory services costs, appraisal costs and the cost of land options associated with Lake Robinson will be paid by the Commission of Public Works, City of Greer, from funds raised by the sale of bonds. The nonfederal cost of construction of Lake Robinson, including recreation development and specific costs will be paid by the Commission from revenue bond sales, construction funds on hand, and/or funds borrowed from the Farmers Home Administration.

The Commission of Public Works expects to request an advance of about \$1,500,000 in PL-566 funds (not to exceed 30 percent of the installation cost of Lake Robinson) for initial construction costs of Lake Robinson. The period of the advance will not exceed five years. The Commission will enter into an agreement, approved by the Farmers Home Administration, for repayment of the advance prior to the execution of a Soil Conservation Service fund obligating agreement. The State Director has tentatively concurred in the proposed advance.

The Commission of Public Works, City of Greer, has projected its municipal and industrial water needs for the foreseeable future and has estimated that the total capacity of the structure will be utilized by the year 2028.

#### PROVISIONS FOR OPERATION AND MAINTENANCE

Each portion of the watershed works of improvement enters the operation and maintenance phase when it is completed. Structural measures are considered complete when they are accepted from the contractor. Vegetative measures are considered completed as soon as adequate cover has been obtained or two growing seasons have elapsed. Sponsors are not expected to bear the entire cost of repairing damages caused by lack of planned vegetative cover if damage occurs before vegetative measures are completed. If damages occur during this period, the Service and the sponsors will enter into a joint agreement to repair the damage.

Land treatment measures, including critical area plantings, will be maintained by the respective landowners in cooperation with the Greenville County Soil and Water Conservation District. The cost will be borne by the landowner. The Service and the State Commission of Forestry will provide technical assistance for maintenance.

The responsibility for maintenance of all structural measures installed in the watershed, except Lake Robinson and the recreation



development, will be assumed by the South Tyger River Watershed Conservation District. The District will use funds from a tax levy on real property in the watershed to maintain the structural measures. The estimated annual operation and maintenance cost of these structures is \$3,000.

The Commission of Public Works, City of Greer, will operate and maintain Lake Robinson. Annual operation and maintenance costs for this structural measure, estimated to be \$1,100, will be financed with funds from their operating budget.

Operation and maintenance of structures will include, but is not limited to mowing, fertilizing, and controlling the vegetation; repair of any damage to the principal spillways, emergency spillways, the ogee spillway, plunge basins, riprapped outlet, channel and embankments; operation of gates on the riser of the Lake Robinson structure to release M&I water; and removal of any floating logs and debris which may affect the operation of the structure.

The Commission of Public Works, City of Greer will be responsible for the operation and maintenance of the recreation development associated with Lake Robinson. The annual operation and maintenance cost is estimated to be \$14,700 and will be financed with funds from their operating budget. A full time employee will be hired to operate and maintain the recreation facilities. During peak use periods, additional help will be procured. The recreational areas will require repair and replacement of facilities, mowing of grassed areas, and custodial, policing, sanitation, safety, and other operational services. No admission or use charges are contemplated.

The M&I pool of Lake Robinson ranges from elevation 863.5 to 889.0. The maximum surface areas of the M&I pool and recreation pool are 800 acres and 250 acres, respectively. Based on reservoir operation studies, considering seepage and evaporation, Lake Robinson will provide the needed water and will retain a near maximum water surface area except during periods of low rainfall. Public recreation will normally occur on the surface of the M&I pool. The water level should not be lowered below elevation 863.5. If it is found that there is a continuing need for the use of the recreation storage for municipal or industrial purposes, the Commission will reimburse the federal government for all PL-566 funds used for public recreation associated with the reservoir.

Lake Robinson will be stocked with game fish and managed according to recommendations by the South Carolina Wildlife and Marine Resources Department.

Specific operation and maintenance agreements between the Service and the sponsors will be executed for each structural measure prior to signing a land rights, relocation, or project agreement. The O&M agreements will contain, in addition to specific sponsor responsibilities for nonstructural and structural project measures, specific provisions for retention and disposal of property acquired or improved with PL-566 financial assistance. O&M agreements will contain a reference to the South Carolina Watershed Operation and Maintenance Handbook, prepared by the Soil Conservation Service.



The South Carolina Department of Health and Environmental Control has designated several points within and immediately below the watershed as water quality stations. They will continue to monitor water quality at these stations and the operation and maintenance of the recreation development to ensure conformance with applicable state laws.

During periods of low stream flow, water will be released through gates installed on principal spillway risers for reservoir management. Released rates will at least equal inflow to the reservoir to provide for downstream use. The South Tyger River Watershed Conservation District will be responsible for releasing water as needed from all floodwater retarding structures. The Commission of Public Works, City of Greer, will release water as needed from Lake Robinson.

The Soil Conservation Service and the sponsors will make a joint inspection annually, or after severe flooding, for three years following installation of each structural measure. Inspections after the third year will be made annually by the sponsors with a copy of their report submitted to the Service representative.

The Sponsors will maintain a record of operations and maintenance activities and inspections in their files. These reports will be made available to the Service upon request.



South Tyger River Watershed, South Carolina

Price base - "as built" for Structures 2, 4 and 5 and channel work; 1974 for all other.

Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.

June 1975





TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

South Tyger River Watershed, South Carolina

Item	(Dollars) 1/					Installation Cost - Other Funds				Total P.L. 566	Installation Cost - Other Funds				Total Installation Cost
	Con- struction	Engi- neering	Land Rights	Relocation Payments	Total	Con- struction	Engi- neering	Land Rights	Relocation Payments	Total	Con- struction	Engi- neering	Land Rights	Relocation Payments	Total
<u>Floodwater Retarding Structures</u>															
2, 4, and 5	281,400	36,600	-	-	318,000	-	-	87,800	-	-	-	-	-	-	87,800
3D	144,000	18,700	-	-	162,700	-	-	94,600	2/	-	-	-	-	-	94,600
6A	133,000	17,300	-	-	150,300	-	-	43,300	3/	-	-	-	-	-	43,300
Subtotal	558,400	72,600	-	-	631,000	-	-	225,700	-	-	-	-	-	-	225,700
Channel Work	8,600	1,100	-	-	9,700	-	-	1,400	-	-	-	-	-	-	1,400
<u>Multiple Purpose Structure Lake Robinson</u>															
Structure	723,700	74,400	368,300	4/	1,184,600	2,230,000	114,400	1,363,500	5/	11,800	3,719,700	-	-	-	4,904,300
Water Release Gates	-	-	-	-	-	18,300	1,100	-	-	-	19,400	-	-	-	19,400
Grubbing M&I Pool	-	-	-	-	-	28,000	1,700	-	-	-	29,700	-	-	-	29,700
Recreational Facilities	70,000	4,200	12,500	-	86,700	70,000	4,200	12,500	-	-	86,700	-	-	-	86,700
Subtotal	793,700	78,600	380,800	-	1,252,900	2,346,300	121,400	1,376,000	-	11,800	3,855,500	-	-	-	4,000,000
Subtotal	1,360,700	152,300	380,800	18,200	1,912,000	2,346,300	121,400	1,603,100	11,800	4,082,600	5,126,800	-	-	-	5,994,600
Project	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Administration	1,360,700	152,300	380,800	18,200	2,154,000	2,346,300	121,400	1,603,100	11,800	4,147,900	308,000	-	-	-	6,302,600
GRAND TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1/ Price base - Structure 2 and channel, 1968, as built; Structure 5, 1969, as built; Structure 4, 1974, as built; all other costs are 1974 prices.															
2/ Includes \$16,000 for changes to fixed improvements.															
3/ Includes \$3,000 for changes to fixed improvements.															
4/ Includes \$83,000 for changes to fixed improvements.															
5/ Includes \$243,000 for changes to fixed improvements.															

June 1975



TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

South Tyger River Watershed, South Carolina

(Dollars) 1/

Item	COST ALLOCATION				COST SHARING				Total	Recreation	Total	
	PURPOSE				PL-566							
	Flood Prevention	Industrial	Recreation	Total	Flood Prevention	Industrial	Recreation	Total				
OTHER												
Municipal												
Municipal												
Flood Prevention												
Industrial												
Recreation												
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1/ Price base - Structure 2 and channel, 1968, as built; Structure 5, 1969, as built; Structure 4, 1974, as built; all other costs are 1974 prices.

2/ Relocation payments.

June 1975





TABLE 2B - RECREATIONAL FACILITIES  
ESTIMATED CONSTRUCTION COSTS

South Tyger River Watershed, South Carolina

(dollars) 1/

Item	Number	Unit Cost	Total Construction Cost
1. Roads, paved	0.17 miles <u>2/</u>	42,000	7,100
2. Parking areas, paved			
a. boats & trailers	50 spaces	420	21,000
b. cars	20 spaces	190	3,800
3. Parking areas, gravel	40 spaces	60	2,400
4. Boat ramp, concrete	1	22,000	22,000
5. Foot trail, unpaved	0.5 miles <u>2/</u>	3,000	1,500
6. Picnic tables, concrete & wood	40	150	6,000
7. Cast iron grills	40	90	3,600
8. Underground waste receptable units	20	55	1,100
9. Picnic shelter, 20' x 40'	2	5,000	10,000
10. Comfort station, 4 unit, 2+2	2	12,000	24,000
11. Water supply & waste disposal system	1	11,000	11,000
12. Electrical distribution system	1	5,000	5,000
13. Seeding & landscaping	1	5,500	5,500
14. Signs & gates	1	1,000	1,000
	Subtotal		<u>125,000</u>
	Contingencies		<u>15,000</u>
	Total Estimated Construction Cost		140,000

1/ Price base - 1974.

2/ Estimated quantity, subject to minor variation at time of detailed design.

June 1975



## South Tyger River Watershed, South Carolina

Item	Unit	Structure Number					Lake Robinson	Total
		2	3D	4	5	6A		
Class of Structure								
Drainage Area	Sq. Mi.	2.80	7.69	2.75	2.81	5.33	33.19 1/	54.57
Controlled	Sq. Mi.	-	-	-	-	-	16.05	
Curve No. (1-day) (AMC II)							68	
Tc	Hrs.	68	68	68	68	68	8.00	
Elevation Top of Dam	Ft.	2.70	4.33	1.79	1.74	3.68	914.0	
Elev. Crest Emergency Spillway	Ft.	967.5	976.0	954.0	982.5	905.5	2/	
Elev. Crest High Stage Inlet	Ft.	965.0	974.0	949.0	980.0	903.5	-	
Elev. Crest Low Stage Inlet	Ft.	960.0	951.5	944.5	975.0	897.5	-	
Maximum Height of Dam	Ft.	950.0	-	937.0	960.5	887.5	-	
Volume of Fill	Cu. Yds.	29	43	28	43	31	77	
Total Capacity	Ac. Ft.	50,000	83,000	53,400	73,000	55,000	325,000	622,000
Sediment Submerged 1st 50 years	Ac. Ft.	580	1,728	619	690	1,442	14,400	19,459
Sediment Submerged 2nd 50 years	Ac. Ft.	-	93	-	89	174	-	
Sediment Aerated	Ac. Ft.	47 3/	93	83 3/	85	174	770	1,608 4/
Recreation	Ac. Ft.	11	51	21	47	55	85	270
Municipal Water	Ac. Ft.	-	-	-	-	-	734	734
Retarding	Ac. Ft.	522	1,491	515	469	1,039	12,811	12,811
Between High and Low Stage	Ac. Ft.	258	-	272	265	497	-	4,036
Surface Area	Acres	12.0	13.0	22.4	14.0	40.0	165.0	266.4
Sediment Pool	Acres	-	-	-	-	-	250.0	250.0
Recreation Pool	Acres	-	-	-	-	-	800.0	800.0
Retarding Pool	Acres	63.7	170.0	67.0	63.0	102.0	-	465.7
Principal Spillway 5/								
Capacity of Low Stage (Max.)	cfs.	33	-	28	31	58	-	
Capacity of High Stage (Max.)	cfs.	90	120	90	110	235	-	
Frequency of Operation-Emer. Spillway	% Chance	2	2	4	4	2	2/	
Size of Conduit	In.	30	30	30	30	42	-	
Emergency Spillway								
Rainfall Volume (ESH) (areal)	In.	5.5	5.5	5.5	5.5	5.5	10.72	
Runoff Volume (ESH)	In.	2.25	2.25	2.25	2.25	2.25	6.60	
Type		veg.	veg.	veg.	veg.	veg.	concrete	
Bottom Width	Ft.	50	110	50	50	90	90 2/	
Slope of Exit Channel	Ft./Ft.	.035	.030	.025	.035	.030	1.43 6/	
Max. Water Surface Elevation	Ft.	-	-	-	-	-	899.1	
Freeboard								
Rainfall Volume (HH) (areal)	In.	8.8	8.8	8.8	8.8	8.8	26.6	
Runoff Volume (HH)	In.	4.92	4.92	4.92	4.92	4.92	21.68	
Max. Water Surface Elev.	Ft.	967.4	975.6	953.8	982.4	905.5	913.9	
Capacity Equivalents								
Sediment Volume	In.	0.39	0.58	0.71	1.47	1.42	0.48	
Retarding Volume	In.	3.49	3.63	3.51	3.12	3.66	-	
Water Supply Volume	In.	-	-	-	-	-	7.24	
Recreation Volume	In.	-	-	-	-	-	0.41	

- 1/ Lake Robinson is in series with Structures 2, 3D, 4, and 5. The total drainage area above Lake Robinson is 49.24 square miles.
- 2/ Crest elevation of 90 foot wide concrete ogee spillway is 889.0. All flow passes through this spillway system. The spillway is designed to convey the freeboard storm. Elevation of top of sediment pool is 860.0 and top of recreation pool is 863.5.
- 3/ 100 year sediment pool, total acre feet.
- 4/ Total sediment submerged in 100 years.
- 5/ Retarding storage determined by floodrouting 6 hour duration storm under antecedent moisture condition III.
- 6/ Face of concrete gravity ogee section.





TABLE 3A - STRUCTURAL DATA  
CHANNELS

South Tyger River Watershed, South Carolina

Channel 1/ Station	Station Numbering for Reach		Drainage Area (Sq. Mi.)	Design Capacity (cfs)	Hydraulic Gradient (ft./ft.)	Channel Dimensions			Aged Velocity (ft./sec.)	Type of Work 3/
	Station	Station				Bottom Width (ft.)	Depth of Flow (ft.)	Aged "n" Value		
Meadow Creek 4/	100+00	129+00	0.39	40	0.00300	4	3.0	0.045	2.4	II
	129+00	150+00	0.56	45	0.00633	4	2.6	0.045	3.3	II
	150+00	180+00	0.60	73	0.00250	10	2.6	0.045	2.5	II
Peck Creek 5/	10+00	64+25	1.50	71	0.00420	6/		0.050	2.1	III

1/ Previously modified channels with perennial flow.

2/ Side slopes of enlarged channels were 2:1.

3/ II - Enlargement or realignment of existing channel or stream.

III - Cleaning out natural and manmade channel (clearing and snagging operation).

4/ Constructed in 1967. Excavation was 5,900 cubic yards.

5/ Constructed in 1970.

6/ Cross sectional area and wetted perimeter below hydraulic grade line at lower end of reach are 33.0 square feet and 21.7 feet, respectively.

June 1975



TABLE 4 - ANNUAL COST

South Tyger River Watershed, South Carolina

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost	Operation and Maintenance Cost	Total
Structural Measures	202,100 <u>4/</u>	18,800 <u>3/</u>	220,900
Project Administration			10,400
TOTAL	202,100	18,800	231,300

1/ Price base - Structure 2 and channel, 1968, as built; Structure 5, 1969, as built; Structure 4, 1974, as built; all other costs are 1974 prices.

2/ Costs were amortized as follows: Lake Robinson 3 1/4 percent interest rate for 100 years; all other structures 3 1/8 percent interest rate for 100 years.

3/ Operation and maintenance for recreation facilities, \$14,700 and operation and maintenance for M&I facilities, \$1,100.

June 1975





TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

South Tyger River Watershed, South Carolina

Item	(Dollars) 1/ Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	11,800	1,600	10,200
Other Agricultural	1,300	200	1,100
Nonagricultural	10,100	1,100	9,000
Subtotal	23,200	2,900	20,300
Sediment			
Overbank deposition	5,500	700	4,800
Reservoirs	19,700	2,000	17,700
Subtotal	25,200	2,700	22,500
Erosion			
Floodplain scour	600	100	500
Subtotal	600	100	500
Indirect	3,900	400	3,500
TOTAL	52,900	6,100	46,800

1/ Price base - current normalized for crop and pasture, 1974 prices for all other.

June 1975



TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

South Tyger River Watershed, South Carolina

Evaluation Unit	(Dollars)							Average Annual Cost 2/	Benefit Cost Ratio
	AVERAGE ANNUAL BENEFITS 1/								
	Damage Reduction	More Intensive Land Use	Municipal & Industrial	Recreation	Secondary	Redevelopment	Total		
Structural Measures 3/	44,800	12,700	145,500	106,600	18,500	27,500	355,000	220,900	1.6 to 1
Project Administration								10,400	
GRAND TOTAL	44,800 4/	12,700	145,500	106,600	18,500	27,500	355,000	231,300	1.5 to 1
1/ Price base - current normalized for crop and pasture, 1974 prices for all other.									
2/ From Table 4.									
3/ Includes three floodwater retarding structures and the channel work which have already been completed.									
4/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$1,960 annually.									

1/ Price base - current normalized for crop and pasture, 1974 prices for all other.

2/ From Table 4.

3/ Includes three floodwater retarding structures and the channel work which have already been completed.

4/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$1,960 annually.

June 1975





## INVESTIGATIONS AND ANALYSES

### Land Use and Treatment

Land use was determined from soil and water conservation district reports, surveys, and field studies. Estimates of future land use and treatment measures were made on the basis of the people involved, the land within the watershed, and present trends. Needed land use adjustments based on soil capabilities were considered in arriving at the land treatment measures planned for the watershed.

The land treatment program was formulated to meet the physical needs of the land. Land treatment goals were established by the soil and water conservation districts. Land treatment goals were based on the need to reduce erosion to within tolerable soil loss limits. When the plan is carried out, the watershed will be a showcase of conservation.

A systematic field survey showed ground cover, forest and hydrologic conditions, and treatment needs. The survey, supporting data, and information from other agencies and forestry officials determined the measures planned.

The costs of installing the land treatment measures were developed by the Soil Conservation Service, the South Carolina State Commission of Forestry, and the U.S. Forest Service. Technical assistance costs were based on the present costs of the going district programs, the going Cooperative Forest Management Program, and the going Cooperative Forest Fire Control Program. Costs of installing land treatment measures were based on present prices paid by landowners and operators in the locality. The amount of private forest land treatment measures needed to meet treatment goals was based on a field survey of the watershed adjusted for expected participation during the installation period.

### Structures

Structures 2, 3D, 4, 5, and 6A, and channel work were described in the 1966 work plan. Structures 2, 4, and 5, and channel work on Peck and Meadow Creeks have been installed. Structure 1 and the other channel work have been deleted and Lake Robinson is being added to the planned work.

Vertical control necessary to survey valley cross sections for evaluating flooding problems and developing topographic maps of reservoir sites was based upon mean sea level datum as established by U.S. Coast and Geodetic Survey and U.S. Geological Survey. Temporary bench marks were established throughout the watershed.

Topographic maps with five foot contour intervals were made of the reservoir area of each floodwater retarding structure. The maps were used to develop stage-area and stage-storage curves and are adequate for final design.

Floodwater retarding structures were designed in accordance with SCS Engineering Memorandum 27. Retarding storage for Structure 3D was estimated from the procedures outlined in SCS Technical Release No. 10.

Retarding storage for Structures 2, 4, 5, and 6A was determined by routing, on the IBM 7090 Computer, a six hour storm under Antecedent Moisture Condition III. The tops of these dams were estimated by graphically routing the freeboard hydrographs.

Horizontal distances for channel design were based on a semi-controlled watershed map. Representative cross sections were used to establish the point where damage begins and to show existing channel features. Channel design was based on Manning's Formula. Channel work consisted of channel enlargement on Meadow Creek and clearing and snagging on Peck Creek.

A topographic map of the Lake Robinson reservoir area, with a five foot contour interval was made by John J. Harte Associates of Atlanta, Georgia, for Enwright Associates, Inc., of Greenville, South Carolina, engineering consultants for the Commission of Public Works, City of Greer. This mapping was compiled by photogrammetric methods from aerial photography. The highest contour mapped was elevation 910.0, four feet lower than the top of dam elevation. The upstream ends of contours 905.0 and 910.0 were not completed. The map was used to develop stage-area and stage-storage curves. These curves were extended to estimate the storage at elevations 905.0, 910.0, and 914.0. During final design, additional topographic data will be obtained.

The Lake Robinson structure was designed in accordance with SCS Engineering Memorandum 27. After consideration of the damage and loss of life that might result from a major breach, the structure was classified as Class "c". The importance of Lake Robinson for municipal and industrial water storage and as a recreation area was also considered. The Class "c" classification requires that the structure pass the runoff from the probable maximum eight hour precipitation (PMP) storm safely without overtopping the dam.

The consultant determined the quantity of storage needed for water supply and recreation. They also determined that the water quality will be adequate for the intended uses and that the site will hold water. The Commission, assisted by the consultant, selected the location of the recreation access area and determined the needed recreation facilities.

The consultant and the Service jointly studied spillway alternatives at the site. An earthfill dam with a concrete ogee spillway was selected after several alternatives were studied. The Design Section, E&WP Unit, South Technical Service Center, assisted in these studies.

The concrete ogee spillway crest was set at the maximum surface elevation of the M&I pool. No floodwater storage was included except that spillway storage impounded during the passage of the freeboard (PMP) storm. Cost studies were made to determine the most economical spillway width and a 90 foot width was selected. The spillway will have a rock foundation. A chimney drain for the non-concrete portion of the dam will be installed to reduce the potential for damage in the event of an earthquake.

Other structural alternatives considered were:

1. An earthfill embankment with a reinforced concrete principal spillway, consisting of a riser at the upstream toe of the embankment and a conduit through the embankment, and a vegetated earth emergency spillway. Several locations for emergency spillways were considered to determine if a non-erosive or a rock spillway could be located. Because of the large drainage area, the volume of runoff in the freeboard design storm and the erosive soils in the emergency spillways considered, an extremely wide spillway system was required. The installation of this alternative was neither practical nor economically justified.
2. An earth embankment with a concrete ogee spillway with its crest at such a level as it would have a one percent chance of operation in any year. A principal spillway with its crest at elevation 889.0, 11 feet lower than the crest of the ogee spillway, was incorporated into the ogee spillway. Analysis indicated that the cost of flood storage in the reservoir was not justified.
3. An earth embankment with a concrete ogee spillway in combination with gates whose bottoms were set at elevation 860.0, the surface elevation of the sediment pool. These gates were to be controlled automatically in response to changes in the water level in the reservoir. The cost of this alternative exceeded that of the selected system and would not be as reliable.
4. An earth embankment with a reinforced concrete principal spillway and chute spillway. This alternative was studied in detail. Possible foundation problems involving seepage through the excavated portion of the chute spillway channel and differential settlement caused by an uneven rock foundation caused this alternative to be discarded.
5. An earth embankment with outlet works for draining the pool and removing M&I water and a concrete side channel spillway. The questionable foundation for the spillway and outlet channel plus the probable cost of the alternative caused this alternative to be discarded.



## Geology

A geologic field inspection was made at all proposed structure sites. Foundation conditions, emergency spillway locations, and borrow areas were examined. Geologic materials and their surface structure were logged for each site.

An estimate of average annual suspended sediment concentrations was made at several watershed locations. The concentrations indicated were obtained by following the procedures outlined in Chapter VIIA of the "Guide to Sedimentation Investigations" prepared by the EQWP Unit of the South Regional Technical Service Center, October 1969. Sediment storage requirements for each structure were determined by following procedures outlined in Chapters 8 and 9 of the Guide.

A study of physical damages to the flood plains of the watershed was conducted by surface inspection of flood plain reaches, followed by hand auger investigations. The extent and degree of swamping were noted. Damages were summarized by evaluation reaches and adjusted for recoverability of productive capacity. Estimates of recoverability were developed from field studies and interviews with landowners. Sediment yields to all impoundments were calculated for present conditions, "future with" and "future without" project. The "future with" yield includes an estimate of the slight amount of channel degradation expected and takes into account the expected urban and industrial expansion predicted for the future. Erosion rates for each soil unit and land use were determined by using the Musgrave Equation (modified). Sediment delivery rates selected were taken from available sediment survey data using the curves from the Guide as references.

In addition to the previous geologic studies, extensive foundation investigations were made for proposed Lake Robinson. Law Engineering Testing Company, Froehling and Robertson Testing Laboratory and the Service participated. The services of the private testing companies were procured by the Commission of Public Works, City of Greer, through their engineering consultants.

Eight holes were drilled into rock to a depth of 40 feet under the planned location of the concrete gravity ogee section. Samples from these rock cores were tested to determine their compressive strength. Packer tests were made in the rock and overlying soil materials to determine their permeability. Triaxial shear tests were made on samples from the overlying materials, abutments, and borrow area.

Bedrock at the site consists of granitic gneiss of the Inner Piedmont Belt. The gneiss is present in several stages of weathering, varying from solid massive layers through broken permeable layers and finally, layers of almost soil-like consistency. The abutments display alternate layers of hard, but fractured gneiss and soft saprolitic or soil-like masses. The rock in the flood plain generally is weathered and permeable in the first three to five feet and becomes solid and very slowly permeable below five feet and continues to at least forty feet. The results of the investigation indicate the foundation is suitable for the proposed structure.



Estimates of sediment storage for Lake Robinson were made as described above for all structures. Sediment storage was computed using a submerged unit weight of 60 pounds per cubic foot and an aerated weight of 95 pounds per cubic foot. The aerated weight was considered similar to the dry unit weights of upland samples. The submerged unit weight was estimated using sediment survey data from the Piedmont area of South Carolina as references.

#### Hydrology

Applicable Soil Conservation Service procedures were followed in making the hydrologic analysis of the watershed and developing hydrographs for structure design.

Reservoir operation studies were made for Lake Robinson. Several studies were made to determine the demand-supply available for different amounts stored. These studies were accomplished by use of the IBM 1130 computer and the following data:

1. Area-storage curves were developed for the reservoir.
2. The most critical drought period on record (calendar years 1952 through 1956) was selected for the study.
3. The U.S. Geological Survey stream gage records on South Tyger River near Reidville, South Carolina, were used to obtain monthly inflow in inches.
4. The following records were used to compute the net evaporation from the reservoir surface:
  - a. U.S. Weather Bureau Class A pan records at Clemson, South Carolina.
  - b. U.S. Weather Bureau standard rain gage at Greenville, South Carolina.
5. A seepage rate of 0.1 feet per month was used.

The engineering consultants determined a 32 mgd yield will be necessary to satisfy future needs. These studies show this yield to be available from the proposed 12,811 acre feet of storage. The Commission of Public Works, City of Greer, has agreed to sell water to the Blue Ridge Rural Water Company, and the projected needs include their requirements.

### Economics

Methods used in making the economic investigations and analyses followed those approved by the Soil Conservation Service in benefit-cost evaluation of land and water resource projects. Basic data were obtained from landowners, agricultural workers, city and county officials, state highway personnel, university and USDA publications, and private engineering firms.

Current normalized prices were used in crop and pasture benefit computations. Current (1974) prices were used for estimating other benefits, installation costs, and operation and maintenance costs. The costs of Structures 2, 4, 5, 3D, and 6A were amortized over a 100 year period using 3 1/8 percent interest rate; the costs of Lake Robinson were amortized over a 100 year period using 3 1/4 percent interest rate.

Sediment damage reduction benefits in Lake Cunningham were based on the cost of removing sediment from the headwaters of the lake, and the devaluation of personal property and pumping station at the lake. The projected sediment accumulation into Lake Robinson from the South Tyger River without the remaining project is 17 acre feet per year and with the project is two acre feet per year.

Municipal and industrial water benefits were estimated to be equal to the cost of the least costly alternative. A single purpose structure at the site of Lake Robinson was determined to be the least costly alternate by the engineering firm representing the Commission of Public Works, City of Greer. An estimated installation cost of \$4,294,000 was amortized at 3 1/4 percent interest for 100 years to determine the annual benefit.

Recreation benefits of 53,000 visitor days per year were valued at \$2.00 per visitor day to determine the annual recreation benefits.

More intensive land use benefits were calculated on the basis of expected increase in crop yields. This increase in yield level would result from increased use of fertilizers and better managerial practices made profitable by reducing the flood hazard. Future flood damages to these higher damageable values were deducted from gross benefits. The soils of the flood plain are mostly Class IIIw. The planned land use is within the capabilities of the flood plain soils.

Benefits from restoration of former productivity were estimated on the basis of flood-free yields. Associated costs and increased damages due to higher damageable values with the project were deducted from gross benefits. Special attention was given in the evaluation procedure to avoid the possibility of double counting benefits.

Redevelopment benefits resulting from installation of project measures are based on utilization of unemployed or underemployed local labor. Wage payments to local labor during construction were estimated to be 20 percent of the construction costs. This value was amortized at 3 1/4 percent interest for 100 years to arrive at annual benefits of Lake Robinson, and at 3 1/8 percent interest for 100 years for all other construction. Fifty percent of the operation and maintenance

costs were used as the value of annual wages paid to local labor. This value was treated as a decreasing annuity for 20 years at 3 1/4 percent interest for Lake Robinson, and 3 1/8 percent interest for all other construction, and converted to an annual equivalent over the project life. This method of amortization complies with SCS Watersheds Memorandum 92 (Rev. 4).

The values of local secondary benefits were estimated from the direct primary project benefits. Indirect and redevelopment benefits were excluded when computing secondary benefits. The values of local secondary benefits induced by the project were estimated to be 10 percent of the increased costs that producers will incur in connection with increased or sustained production and costs associated with development of the recreational areas. The local secondary benefits from recreation were estimated as being 12 percent of primary recreation benefits. Secondary benefits from the national viewpoint were not evaluated.

Installation costs of Lake Robinson were allocated by the Specific Cost-Remaining Benefit Method. Specific costs included all land rights, grubbing part of the M&I pool, M&I water release gates, recreation area construction costs, operation and maintenance for the recreation area and M&I release, engineering costs for the release gates, and grubbing reservoir, engineering costs of the recreational development, and relocation costs. All other costs were determined to be joint costs and were allocated as follows: 9.6 percent to flood prevention, 60.6 percent to M&I water and 29.8 percent to recreation. Project administration costs were not allocated.

Land rights costs for Lake Robinson were allocated as follows:

1. Costs of the area for the sediment pool and recreation pool were allocated to recreation (250 acres).
2. Costs of 550 acres under the M&I water were allocated to the M&I purpose.
3. Costs of the area surrounding the M&I pool to be purchased (296 acres) were allocated to recreation.
4. Costs of the area for recreation facilities (25 acres) were allocated to recreation.
5. Costs of the areas needed for the dam and borrow (25 acres) and 48 acres of the flood pool being purchased were allocated to recreation and M&I storage, 50.9 percent and 49.1 percent, respectively.

All land rights costs for the single purpose floodwater structures were allocated to flood prevention.





## APPENDIX A - SOUTH CAROLINA DRINKING WATER STANDARDS 1/

The South Carolina Department of Health and Environmental Control collects samples of water from the distribution systems of public water supplies in South Carolina, and conducts chemical analyses in accordance with the Law, Rules and Regulations for Waterworks Systems in the State of South Carolina. These analyses are designed to determine if the finished water meets standards for chemical quality as set forth in the 1962 U.S. Public Health Service Drinking Water Standards. These analyses are also used to evaluate treatment processes where such processes are employed.

Characteristic or Chemical Substance	Limit
Total Solids	Should not exceed 500 mg/l
Turbidity	Should not exceed 5 t.u.
Color	Should not exceed 15 units
Alkalinity	Should not exceed 500 mg/l
Calcium	Related to hardness
Magnesium	Related to hardness
Hardness	Should not exceed 100 mg/l
Sodium	No standard. Provided as information for medical doctors when requested
Iron	Should not exceed 0.3 mg/l
Chloride	Should not exceed 250 mg/l
pH	Acceptable range from 6.5 to 8.5
Manganese	Should not exceed 0.05 mg/l
Copper	Should not exceed 1.0 mg/l
Zinc	Should not exceed 5.0 mg/l
Potassium	No standard. Provided as information for medical doctors when requested
Mercury	Should not exceed 0.5 ppb
Chromium	Should not exceed 0.05 mg/l
Cadmium	Should not exceed 0.01 mg/l
Lead	Should not exceed 0.05 mg/l

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1/ Law, Rules and Regulations for Waterworks Systems in the State of South Carolina, South Carolina State Board of Health, November 1970.



## APPENDIX B - QUALITY STANDARDS FOR CLASS "B" WATERS 1/

Class "B" waters are suitable for domestic supply after complete treatment in accordance with requirements of the South Carolina Department of Health and Environmental Control. They are also suitable for propagation of fish, industrial and agricultural uses and other uses requiring water of lesser quality.

Items	Specifications
1. Fecal coliform	Not to exceed a geometric mean of 1000/100 ml based on five consecutive samples during any 30 day period; nor to exceed 2000/100 ml in more than 20 percent of the samples examined during such period (not applicable during or following periods of rainfall).
2. pH	Range between 6.0 and 8.5, except that swamp waters may range from pH 5.0 to pH 8.5.
3. Dissolved oxygen	Daily average not less than 5 mg/l, with a low of 4 mg/l, except that swamp waters may have an average of 4 mg/l.
4. Phenolic compounds	Not greater than 1 microgram per liter unless caused by natural conditions.

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1/ Water Classification Standards System for the State of South Carolina, South Carolina Pollution Control Authority, 1972.





APPENDIX C - SURFACE WATER QUALITY IN SOUTH TYGER RIVER WATERSHED 1/

Station Number and Location	Date of Sample	Water Temperature (centigrade)	pH	Dissolved Oxygen (MG/L)	Fecal Coliform (No./100ML)	Biochemical Oxygen Demand 5 Day (MG/L)
B-317 South Tyger River at South Carolina Highway 253, below Tigerville	7/25/74	-	6.2	-	725	2.4
	8/23/74	-	6.5	-	500	1.7
B-305 Mays Bridge Road off South Carolina Highway 92, northwest of Greer	7/17/72	18.0	6.8	8.0	180	0.2
	5/30/73	16.0	6.1	10.4	390	1.6
	7/24/73	20.0	7.1	8.8	-	-
	10/ 5/73	18.0	7.3	9.5	2,100	1.4
	5/28/74	18.0	-	8.5	575	1.3
	6/24/74	19.0	-	8.8	-	-
	7/26/74	21.0	-	8.0	-	-
B-304 Beaverdam Creek at South Carolina Highway 92, five miles northwest of Greer	7/17/72	18.0	-	7.8	70	0.4
	5/30/73	16.0	7.1	10.5	150	1.5
	7/24/73	21.0	7.3	8.3	-	-
	10/ 5/73	18.5	7.25	8.9	775	1.3
	5/28/74	18.0	-	9.0	1,600	1.3
	6/24/74	20.0	-	8.6	-	-
	7/26/74	20.0	-	8.5	-	-



# APPENDIX C - SURFACE WATER QUALITY IN SOUTH TYGER RIVER WATERSHED 1/

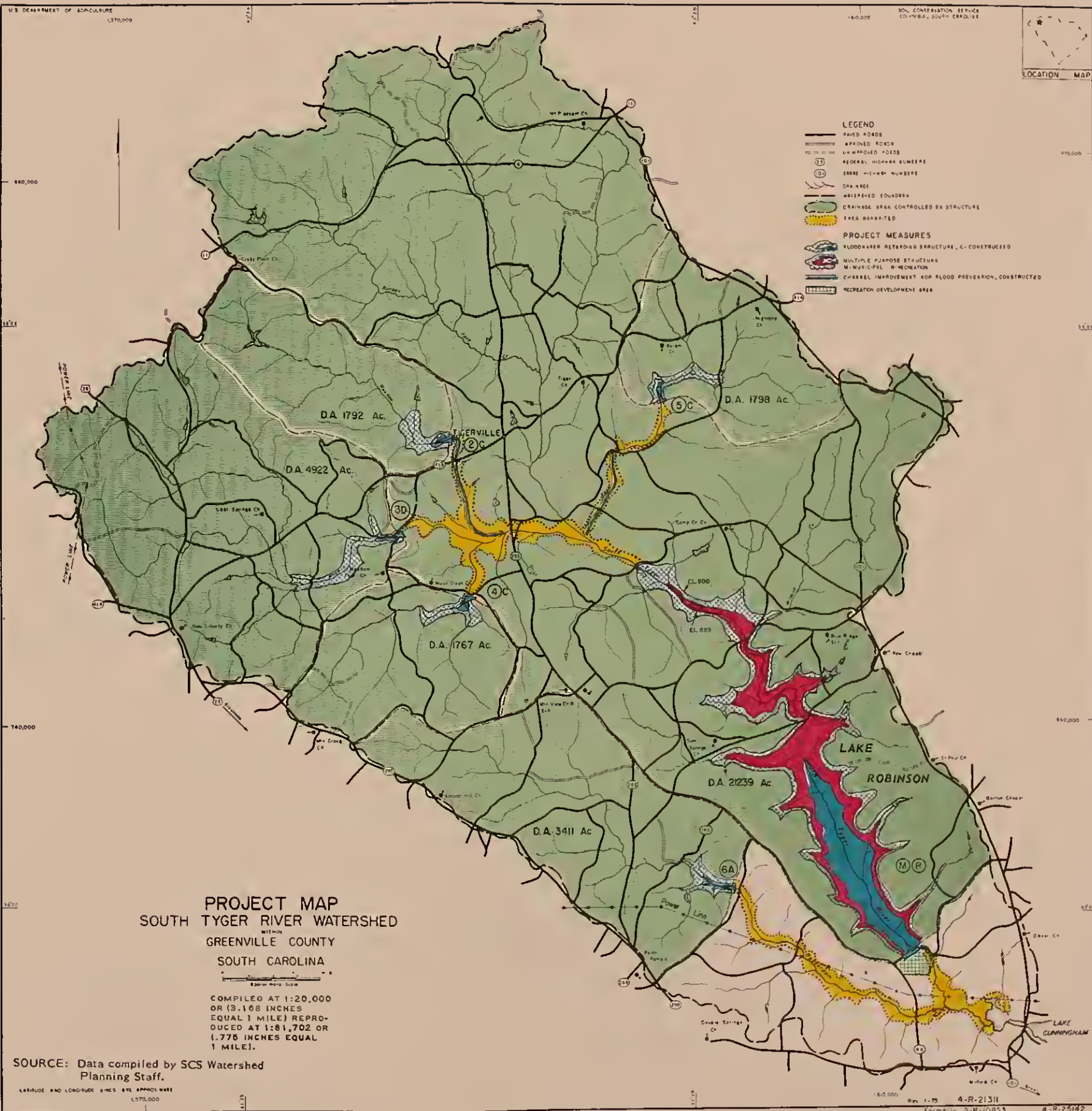
Station Number and Location	Date of Sample	Water Temperature (centigrade)	pH	Dissolved Oxygen (MG/L)	Fecal Coliform (No./100ML)	Biochemical
						Oxygen Demand 5 Day (MG/L)
B-149 South Tyger River below Greer Reservoir at bridge on South Carolina Highway 14	6/12/62	23.5	6.9	9.2	-	1.3
	6/13/62	24.0	6.8	8.9	-	1.6
	10/ 8/62	21.5	7.0	8.8	-	1.4
	5/28/63	18.0	6.9	9.6	-	-
	5/29/63	19.5	6.8	8.9	-	-
	6/ 5/63	23.5	6.9	8.5	-	1.3
	9/26/68	23.0	7.8	8.4	-	1.4
	9/27/68	21.0	6.9	8.8	-	1.3
	7/ 8/71	23.0	6.5	8.3	-	2.4
	8/10/71	21.0	5.8	8.4	-	1.7
	7/17/72	21.0	6.7	7.2	-	0.1
	5/30/73	19.0	6.9	11.9	660	2.5
	7/ 9/73	25.0	7.1	9.5	30	0.7
	10/ 5/73	20.0	6.9	9.3	369	2.2
	6/24/74	19.0	-	9.0	-	-
	7/26/74	24.0	-	8.4	-	-

1/ Computer Data, Surface Water Quality Samples, South Carolina Department of Health and Environmental Control, 1974.





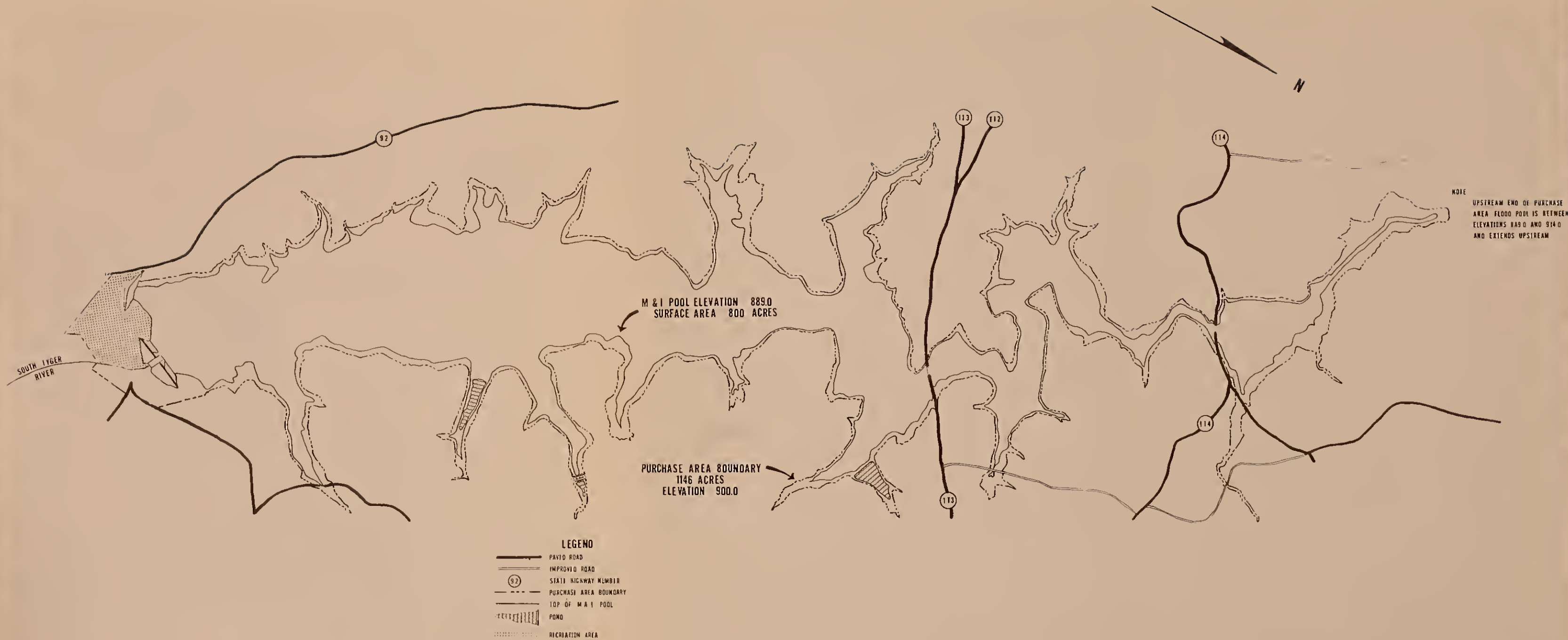






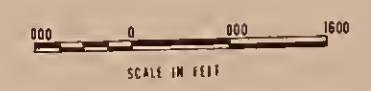






NOTE  
UPSTREAM END OF PURCHASE  
AREA FLOOD POOL IS BETWEEN  
ELEVATIONS 890.0 AND 914.0  
AND EXTENDS UPSTREAM

- LEGEND**
- PAVED ROAD
  - IMPROVED ROAD
  - STATE HIGHWAY NUMBER
  - PURCHASE AREA BOUNDARY
  - TOP OF M & I POOL
  - POND
  - RECREATION AREA



**PUBLIC RECREATION DEVELOPMENT AREA**  
**SOUTH TYGER RIVER WATERSHED**  
LAKE ROBINSON  
GREENVILLE COUNTY, SOUTH CAROLINA  
U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE  
COLUMBIA, SOUTH COLUMBIA



